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MODERN BREWERY REFRIGERATING PLANT

Details of Equipment of Bartels Brewing Co.'s Plant, Syracuse, N. Y., with Special Reference to Direct Expansion and Brine Piping

MECHANICAL REFRIGERATION IN A BREWERY varies considerably from that in other industries, and may consist of an entire direct-expansion system, a combination of direct-expansion and brine-circulating systems or an entire brine system. The system in most common use is the direct-expansion for cooling the various departments and brine circulation for the attemporators in the fermenting vats or tubs.

Among the principal applications of mechanical refrigeration to brewery practice are:—Cooling of the wort from the temperature of water as it can be obtained to the temperature of the fermenting vat; withdrawal of heat developed by the fermentation of the wort; keeping the cellars, store-rooms and various departments at a uniform low temperature; cooling the brine and water for supplying the attemperators in the fermenting vat; cooling the rooms for the storage of wort and the cooling of the air for the malt houses.

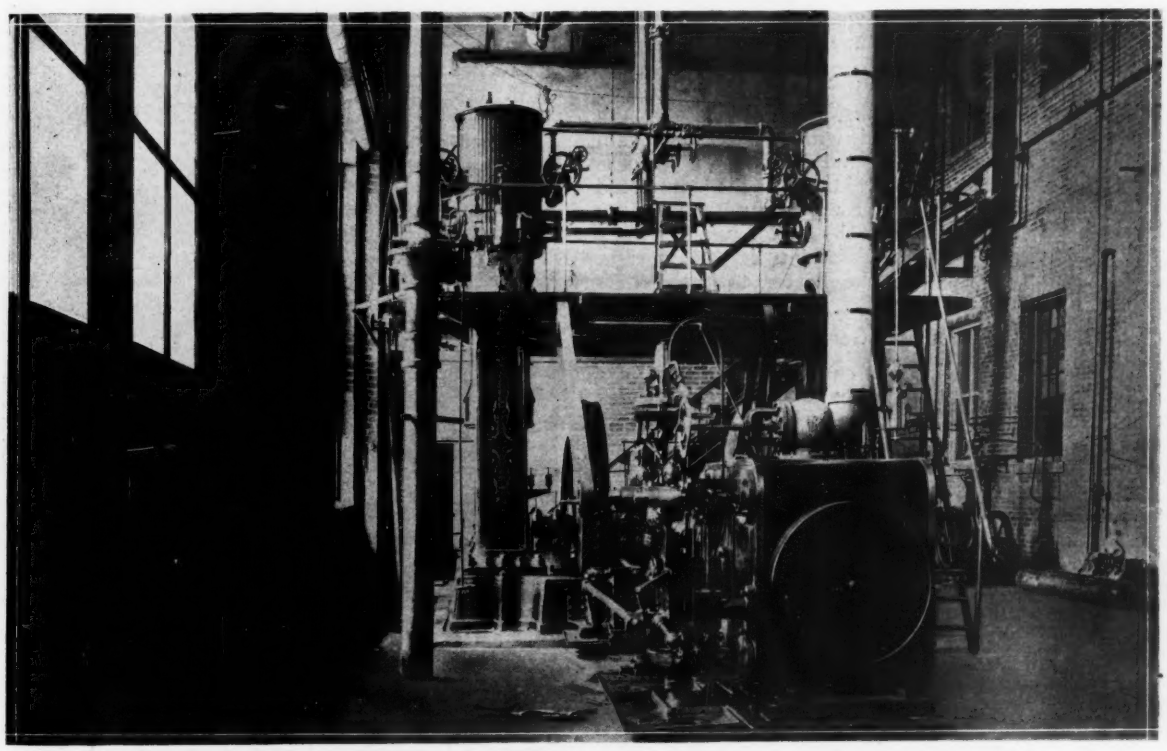


FIG. 3. WEST END OF ENGINE ROOM, SHOWING 150-TON BUFFALO COMPRESSOR FROM STEAM END

An example of a modern refrigerating plant using direct-expansion for cooling the various departments, and a brine system for the attemperators, is found in Bartels Brewing Co.'s plant, at Syracuse, N. Y., which

has an annual capacity of 500,000 barrels, or nearly 1400 barrels daily, for 360 working days.

Boilers and Feed Water

IN the boiler room there are 4 72-in. by 20-ft. Phoenix Iron Works' boilers of the return tubular type, rated at 175 hp. and containing 180 4-in. tubes; and a 72-in. by 16-ft. Mace Bros. boiler, which contains 130 3-in. tubes. Steam pressure is maintained at 100 lb. The

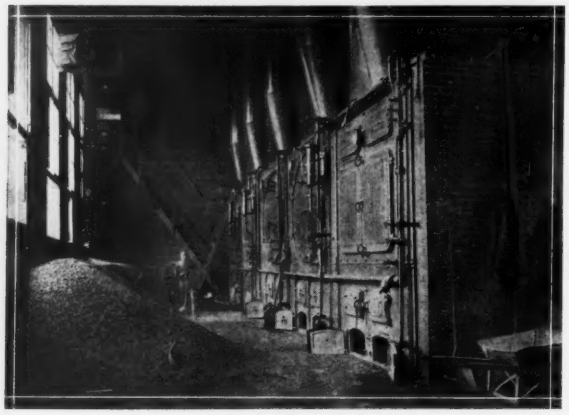


FIG. 1. BOILER ROOM

usual accompaniment of auxiliary apparatus, including gages, water columns, safety valves, etc., is included in the equipment. The fuel used is bituminous coal, hauled from the railroads in wagons and dumped into a storage space in the boiler room, adjacent to the boilers.

City water is used for boiler feed purposes which flows into 2 large steel tanks, through a Berryman feed water heater connected with an exhaust main leading from the compressors and engines. From these tanks where the temperature of the water is maintained at from 208 to 210 deg. F., the water is pumped to the boilers by a Dean, 9 by 5¼ by 12-in. pump. By a special arrangement of valves and piping, city water may be pumped through the heater to the boilers without using the tanks.

Engines and Generators

THE engine and generator equipment consists of a 9 by 12-in. Straight Line engine, direct-connected to an Onondaga 30-kw. d.c. generator, rated at 125 volts and 240 amperes, operating at 240 r.p.m.; one 10 by 12-in. Straight Line engine direct-connected to a Crocker-Wheeler 25-kw. d.c. generator, rated at 125 volts and 280 amperes, running at a speed of 300 r.p.m.; one De Laval turbine-generator, rated at 110 brake hp. or 75 kw., operating at 1200 r.p.m., with a 4-in. steam main and an 8-in. exhaust.

The turbine generators are the Bullock twin type, rated at 110 volts, and 341 amperes, speed 1200 r.p.m. All 3 units are controlled from the switchboard, containing the usual controlling and indicating instruments. The 2 engine-driven units and the twin turbine-driven generators operate in parallel on a common 3-wire system. Electric motor drive and electric lighting are used throughout the establishment.

Ammonia Compressors and Auxiliaries

THERE are 3 ammonia compressors supplying the direct-expansion piping and the brine cooler, with dimension and ratings as follows:

One 150-ton Buffalo double-acting vertical compressor with 2 cylinders 14 by 30 in., direct-driven by a 26 by 42-in. horizontal Corliss release-gear type steam engine operating at 40 r.p.m.; one 65-ton Buffalo double-acting vertical compressor with 2 ammonia cylinders, 12 by 24 in., direct-driven by a 15 by 24-in. steam engine of the same type as that driving the 150-ton compressor, operating at 60 r.p.m.; one De La Vergne 60-ton single ammonia cylinder, 9 by 26 in., direct-driven by a 16 by 26-in. horizontal steam engine operating at 60 r.p.m. The ammonia head pressure is maintained at from 120 to 135 lb. with a back pressure from 15 to 28 lb.

From the compressors the discharge pipe passes through an oil separator, thence to the condenser manifold and condenser, to the receiver and feed manifold from which the ammonia pipe lines lead to the cooling rooms and brine cooler.

Condensation of the ammonia from the 3 compressors is handled by a York 3-stand surface condenser, consisting of 2-in. ammonia pipe 24 pipes high, located on the third floor of the main building. It is constructed with a horizontal preliminary section of 4 pipes; the hot gas from the compressors is delivered to this section, which is submerged in water, and then passes to the upper pipe of the vertical section, the liquid outlet being at the bottom.

The object of the preliminary section is to remove the heat of compression from the gas before it comes into contact with the cold condensing water at the top of the condenser; it is provided with a drain and

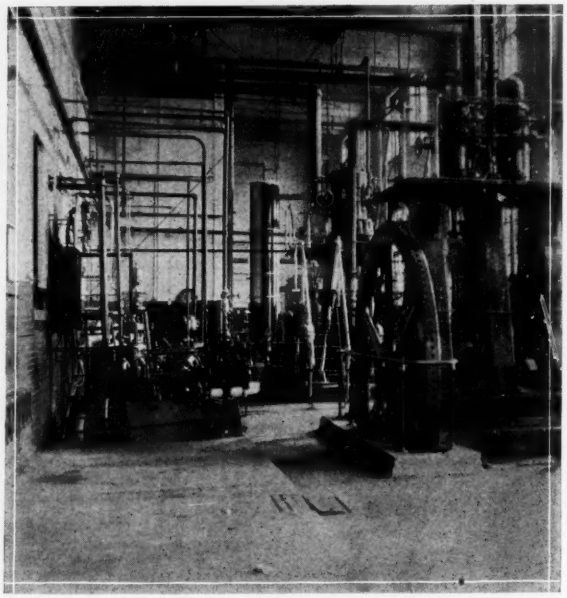


FIG. 2. EAST END OF ENGINE ROOM; BUFFALO 65-TON COMPRESSOR IN THE FOREGROUND, AND DE LA VERGNE 60-TON COMPRESSOR IN THE REAR

trap leading to the liquid header to remove any gas that may be condensed in this section, and also to prevent the coil from becoming gas bound.

Each coil is provided with the necessary gas and liquid shut-off valves; also a purging valve to remove air or foreign gases from the system. Above each coil is a slotted pipe with a leveling device to insure an even distribution of water.

Cooling Wort

WORT, as supplied by the cokers, is boiling hot, and has to be cooled to the temperature of the fermenting tubes. It is first cooled in vats exposed to the atmosphere for about 2 or 3 hr. and is then allowed to trickle over a bank of coils through which cold water circulates at 60 to 70 deg. F. The wort then passes over coils through which brine circulates, and

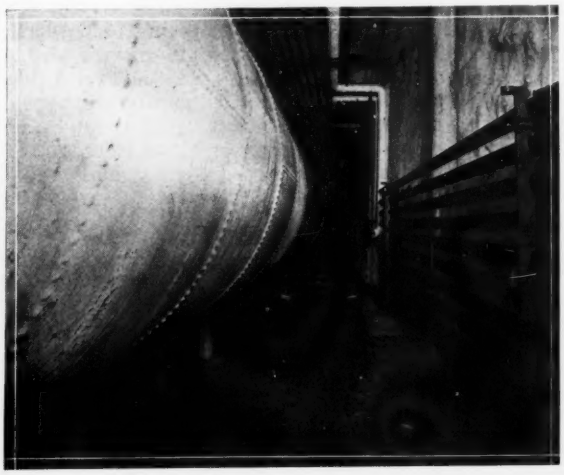


FIG. 6. STORAGE CELLAR, SHOWING ARRANGEMENT OF DIRECT EXPANSION AMMONIA PIPING

is lowered to the approximate temperature of the fermenting vats, about 40 deg. F. for lager and 55 deg. F. for ale. This is known as the Baudelot cooling system for wort.

Fermenting Vats and Attemperators

THERE are 5 lager-fermenting vats, whose diameter at the bottom is 15 ft. 4 in., and at the top 14 ft. 4 in.; and the height 13 ft. 11 in. In each tub is an attemperator consisting of a coil of 3-in. galvanized iron pipe, 10 ft. in diameter, which is placed 12 in. below the liquid level, and supported from the top by 3 ⅜-in. galvanized iron rods, placed 120 deg. apart. The 2 pipe ends extend out through the side of the

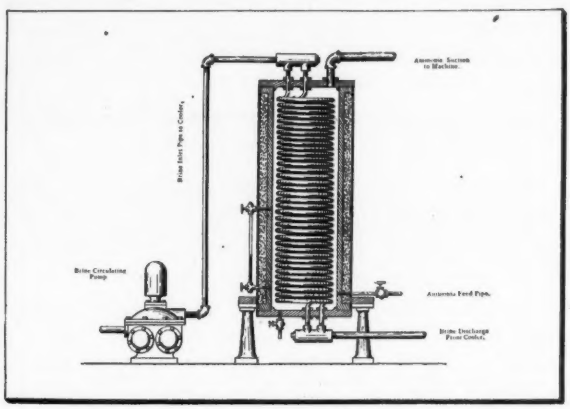


FIG. 5. SECTIONAL VIEW OF BRINE COOLER

vat, one above the other, and are secured inside and outside by lock nuts. The threaded ends extend 1½ in. outside of the lock nut to which are attached the various connections to the brine cooler.

There are 10 ale-fermenting vats, 15 ft. 4 in. in diameter at the bottom, 14 ft. 9 in. at the top, and 9 ft. 11 in. in height. The attemperators consist of 2-in. galvanized iron pipe, bent into a spiral 6 pipes high, spaced 6 in. apart. The coil is supported in 3 places 120 deg. apart, by 2 pieces of galvanized strap iron, bolted one on each side of the coils, standing on the bottom of the tubs. The ends of the pipe pass through the side of the tub and the arrangement of lock nuts and pipe connections is similar in every respect to that of the lager tub. The upper connection to the attemperator is connected through a discharge pipe leading from the cooler and the lower connection to a suction pipe returning to the cooler through a circulating pump.

Brine Cooler

BRINE for the attemperators is cooled by a brine cooler having 90 tons refrigerating capacity, which keeps the brine at a temperature of from 0 to 6 deg.+ F., and consists of a heavy iron shell or container which is filled with spiral pipe coils, the ends of which

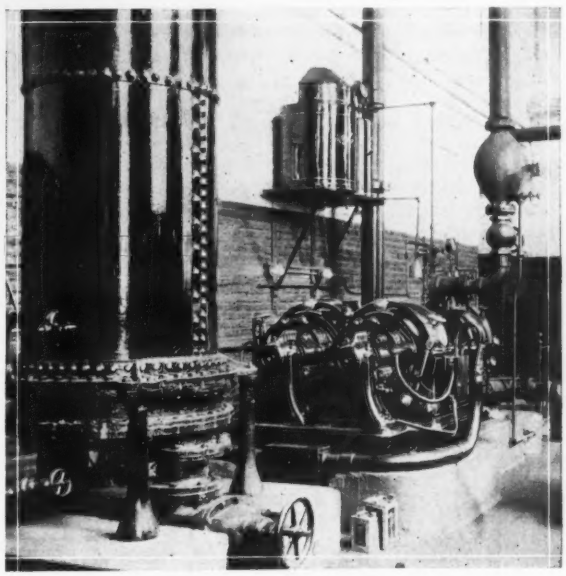


FIG. 4. DE LAVAL TURBINE GENERATOR SET

project through the heads of the shell. The liquid ammonia is expanded in the shell, entering at the expasion valve near the bottom of the cooler and leaving it after having performed its work near the top where the suction pipe, leading to the ammonia compressor, connects. The brine is circulated through the coils entering at the top and leaving at the bottom of the cooler.

As the brine coils are surrounded by the expanding cold ammonia gas, every portion is effective and a continuous change of temperature is produced between the expanding ammonia gas and the circulating brine, so that the latter in its downward passage through the coils is cooled to any desired temperature, according to the rapidity of its flow. As the expansion occurs in the shell, there is no back pressure.

Ammonia Piping

FOLLOWING are data on the direct-expansion ammonia piping which will serve to illustrate a system laid out according to modern refrigeration practice. The departments in a brewery where cooling is

required are: Lager and ale fermenting rooms; yeast room; hop cellars; ale chip carbonating room; ale and lager racking rooms; ale and lager cellars. In the ale fermenting room the cubical contents is 75,830 ft.; the room is maintained at an approximate temperature of 55 deg. F. The ratio square feet of outside ammonia pipe surface to the contents of the room is 1 to 63 in cubic feet. There are 1200 lineal feet of 2-in. ammonia pipe, made up into 2 coils of 600 ft. each, 6 pipes deep, placed 10 in. from the side walls and 6 in. from each other.

The cubic contents of the lager fermenting room is 46,900 ft., and it is maintained at a temperature of approximately 42 deg. F. There are 3500 lineal feet of 2-in. ammonia pipe, made up into 3 coils containing 1166 ft. each, divided into 2 stacks 9 pipes deep and 2 pipes wide, placed 6 in. from the wall and 6 in. between each other. In the ale fermenting room the pipes are placed transversely on the side walls; in the lager fermenting room they are located one set on each side wall and one suspended from the ceiling.

Hop cellars are maintained at temperatures ranging from 33 to 36 deg. F. There are 2 hop cellars, one with 24,610 cu. ft. contents, and one with 2580 cu. ft. contents; the larger cellar has a ratio of 1 to 16, and contains 1538 ft. of 2-in. ammonia pipe, and the small hop cellar contains 343 ft. of 2-in. ammonia pipe, with a ratio of 1 to 7. In the ale chip room the cubic contents is 53,295 ft., the ratio 1 to 26, with 2000 lineal feet of 2-in. ammonia pipe suspended from the ceiling, 15 in. between centers; the temperature is maintained at 36 deg.

Cubical contents of the ale-racking room is 70,130 ft., with a ratio of 1 to 20, the temperature being maintained at about 40 deg. F. There are 3600 lineal feet of 2-in. ammonia pipe, arranged in 2 stands on 3 sides of the room. In the lager racking room the cubic contents is 44,478 ft., and there are 2020 ft. of 1½-in. ammonia pipe, and 980 ft. of 2-in. ammonia pipe.

In the ale cellar, the cubical contents is 32,760 ft., with a ratio of 1 to 29.4 and a temperature of 40 deg. F. There is 1100 ft. of 2-in. ammonia pipe on 4 sides of the room. The lager settler cellar has a cubical contents of 14,136 ft., a temperature of 46 deg. F., and a ratio 1 to 12. It contains 1158 ft. of 2-in. ammonia piping.

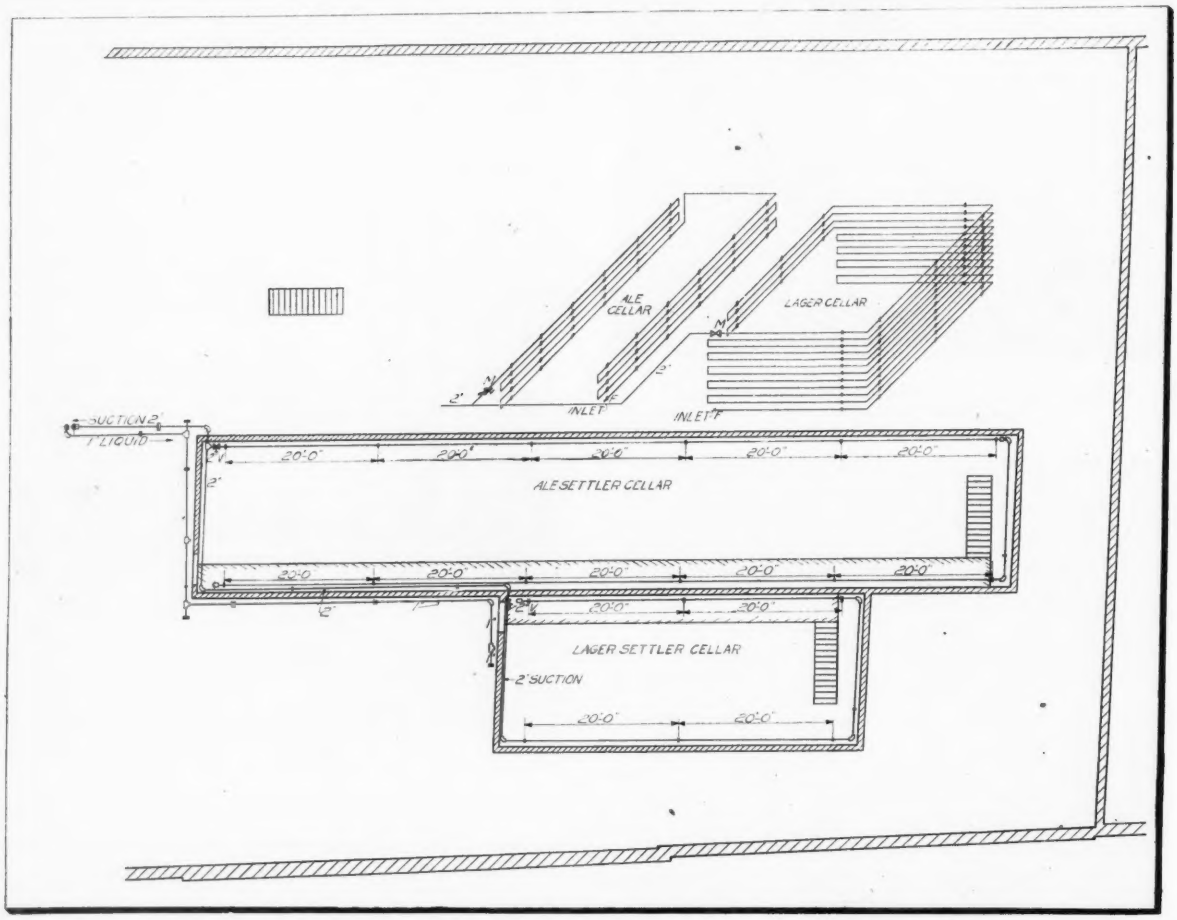


FIG. 7. PLAN AND ISOMETRIC VIEW OF AMMONIA PIPING IN ALE AND LAGER CELLARS

FOR SMALL SIZES of pipe a process, known as "spellerizing" has been developed by the National Tube Co., to give a uniformly dense surface to steel piping adapted to resist corrosion and pitting. This process consists in running the heated bloom through rolls, having projections on their working surface, then running the bloom through smooth faced rolls and repeating the operation, thus kneading the surface and compacting it. The process is applied to pipe 4 in. and under, although it can be used in special cases for pipe a few sizes larger than 4 in.

DESIGN OF STEAM PIPING SYSTEM

Proper Arrangement of Machinery and Piping Reduces Size of Headers, Typical Examples

By Wm. F. Fischer

IN the general run of steam power plant design it is customary to connect a number of boilers, engines, turbines, pumps, etc., to one steam main, this main being known as the main steam header, which conveys the steam from the several boilers in the system, and distributes it to the different prime movers. In many existing power stations the main steam header is unnecessarily large and costly. The writer recently visited a steam power plant rated at about 3000 kw. capacity, and was surprised to find a 20-in. main steam header taking care of 6 boilers, 2 turbines, 1 steam-driven exciter set and a steam pump.

In one of the large central power stations rated at approximately 100,000 kw., the main steam header is only 14 in. inside diameter, and the steam flow in certain branches of the system is not far from 20,000 ft. a minute velocity.

In the earlier days of steam engineering it was customary to provide steam headers of very large diameter, the object of the large header being, to provide a large volume of steam as close to the engine cylinder as possible, from which the engine could draw steam more rapidly when overloaded than would be possible through a smaller header. When steam is drawn rapidly from certain type boilers there is a marked tendency for the boilers to prime, thus throwing off large quantities of water with the steam, which is carried through the piping system to the engine cylinders. The large steam header prevented this priming action to a large extent.

In modern steam power plant practice the main steam header is, quite often, made the same size as the largest branch pipe leading from it, in which case, large separators of the receiver type are placed near the throttle valve of each engine or turbine, as the case might be. These separators give much better results than the old-fashioned headers as they provide for greater storage capacity at a point nearer the engine cylinder, make possible a much smaller steam header and branch pipes, and thus greatly reduce the cost of the piping system throughout.

Separators also ensure drier steam to the engines which they serve, and cut down the combustion and radiation losses to a large extent. In rare cases, it might be found practicable to place the main steam header very close to the engines, in which case the large header would be of same value as a receiver, and might thus justify its use as such.

In designing piping systems where receiver type separators are used, it is advisable to make the connection between the separator and engine the same size as called for by the engine manufacturer. The pipe at the inlet side of the separator, or the pipe connecting the separator with the main steam header may be reduced 1 or 2 sizes, depending upon the conditions. As a general rule, the main header is best placed in the boiler room, over the boilers or run along the wall in the rear of the boilers with branch pipes leading off to the different prime movers.

In steam power plants where the boilers and engines are placed back to back in separate buildings, with a division wall between them, the main steam header may be carried on the division wall at the rear of the boilers, and the engine branches taken off at uniform points along its length as shown in Fig. 1. In this case the flow of steam in the main header will be fairly uniform and direct from boilers to engines, and the main steam header may be made considerably smaller in size than if the steam flow, from boilers to engines, was all in one direction as shown in Fig. 2. In Fig. 2 the boiler and engine rooms are placed end to end and for the purpose of comparing the 2 stations it is assumed that the same number and size of boilers, engines, pumps, etc., are used in each case.

In designing a system of steam piping it is advisable to keep the velocity of steam as nearly uniform as possible throughout the system. In order to keep the steam flow uniform in all branches of the piping system special size pipes would be required, therefore, it is customary to accept the manufacturer's nearest pipe size best suited to the given conditions.

Estimating Pipe Sizes from Table

FOR convenience in estimating the capacity of steam pipes the writer has prepared the tables given in the Reference Tables of this issue. The first column gives nominal sizes of manufacturers' standard weight steam pipes, and the last column, the internal area

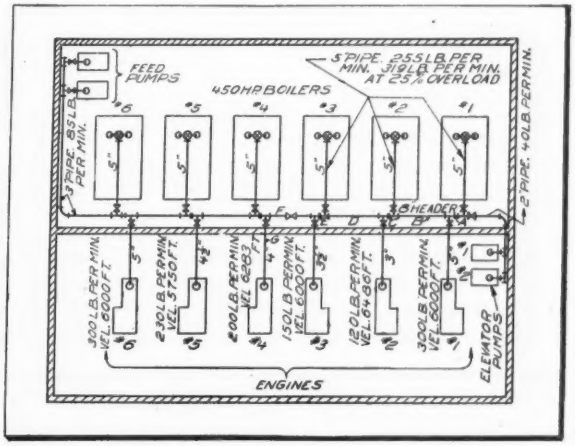


FIG. 1. BACK TO BACK ARRANGEMENT OF BOILERS AND ENGINES, PERMITTING USE OF SMALL HEADER

of the pipe in square inches. In the second column is given the velocity of the steam in feet per minute, i. e., 4000, 6000, 8000 and 10,000 ft. respectively. In the other columns, under the given pressure will be found the weight of steam discharged in pounds per minute at the given pressure and given velocity. The table is arranged for saturated steam.

For example: How many pounds of steam, at 150 lb. gage pressure, will flow through a standard 3-in. pipe, in one minute, if the steam is flowing with a velocity of 8000 ft. a minute? In column headed 150 lb. gage pressure, find opposite 3-in. standard pipe and 8000 ft. a minute velocity, a discharge of 149 lb. per minute.

Example 2. If 120 lb. of steam is discharged through a 3-in. standard pipe, in 1 minute, at a pressure of 150 lb. gage, what will be the velocity of flow in the 3-in. pipe in feet per minute?

Opposite 3-in. pipe, in column headed 150 lb. gage pressure, we find that 120 lies between 111 and 149, consequently the velocity will be between 6000 and 8000 ft. a minute and may be found by multiplying the given discharge, 120 lb., by the next highest velocity, 8000 ft. a minute, and dividing by the weight of steam discharged at this velocity, 149 lb. a minute.

Therefore we get $120 \times 8000 \div 149 = 6443$ ft. a minute, the velocity corresponding to a discharge of 120 lb. of steam a minute, when discharging through a 3-in. pipe at 150 lb. gage pressure. In computing the table, no account was taken of friction. For pipe lines over 100 ft. in length it is advisable to estimate the pressure drop or friction loss, rules for which will be given later. These tables are computed from the following formulae:

$$V = \frac{144\,P\,S}{A}, \text{ or } P = \frac{A\,V}{144\,S}$$

In which A=internal area of pipe in square inches. P = weight of steam discharged through pipe, in pounds a minute. V=velocity of steam flow, in feet a minute. S=specific volume, or number of cubic feet in 1 pound of steam at the given pressure.

In Fig. 1 there are shown 6 boilers of 450 hp. each, 2 feed pumps, 2 elevator pumps, and 6 reciprocating engines. The steam consumption of the engines and pumps is as given on the sketch, in pounds a minute. The steam pressure carried at the boilers is 150 lb. per square inch gage. Saturated steam is

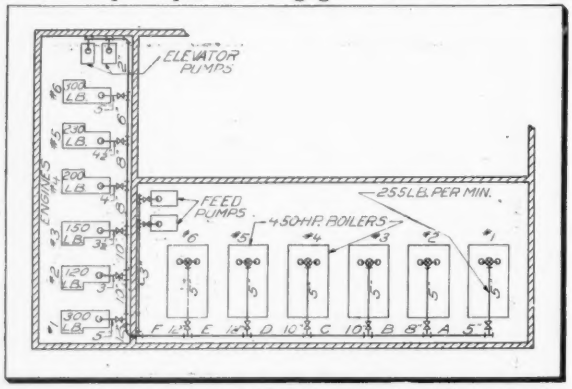


FIG. 2. END TO END BOILER AND ENGINE ARRANGEMENT, REQUIRING LARGE HEADER

used in this plant, and the velocity in the piping system is assumed as 6000 ft. a minute in calculating the pipe sizes. Assuming an evaporation of 34 lb. of water per boiler horsepower per hour, each boiler will evaporate $34 \times 450 \div 60 = 255$ lb. of water a minute at normal rating.

Looking down column under 150 lb. gage pressure, we find that a 4½-in. pipe will discharge 240 lb. a minute at a velocity of 6000 ft. a minute, and a 5-in. pipe will discharge 300 lb. a minute at the same velocity. The 5-in. pipe is selected. The actual velocity in the 5-in. pipe corresponding to a discharge of 255 lb. of steam a minute will be $255 \times 6000 \div 300 = 5100$ ft. a minute.

At 25 per cent overload, each boiler will evaporate $255 \times 1.25 = 319$ pounds of water a minute, and the velocity in the 5-in. pipe will be very close to 6000 ft. a minute as given in the table.

Engines No. 1 and 6 consume 300 lb. of steam a minute each and from the table a 5-in. pipe is found to be the proper size for a velocity of 6000 ft. a minute.

Engine No. 2 requires 120 lb. of steam a minute. Looking in the table we find a 3-in. standard pipe to be the nearest size for a velocity of approximately 6000 ft. a minute, and the actual velocity in the 3-in. pipe, when discharging 120 lb. a minute, will be $120 \times 6000 \div 111 = 6486$ ft. a minute.

The other sizes and velocities are found in a similar manner, and are as given on the sketch.

Having fixed the sizes of the boiler and engine branches, it is next required to determine the size of the main steam header.

In order to proportion the main steam header for the heaviest draft of steam through any section of the header, suppose we assume boilers No. 1, 2 and 3 to be in operation, supplying steam to engines No. 4, 5 and 6, and assume that boilers No. 4, 5 and 6, and engines No. 1, 2 and 3 are shut down. In this case all of the steam from boiler No. 1 flows through pipes A and B. The steam from boilers No. 1 and 2 flows through pipes C and D, and the steam from all 3 boilers, No. 1, 2 and 3, must flow through pipes E and F before reaching the first engine branch supply pipe, G. Therefore, the heaviest draft of steam will be through sections E and F of the main header.

Engine No. 4 requires 200 lb. of steam a minute; engine No. 5, 230 lb.; engine No. 6, 300 lb. a minute, and the feed pumps, 85 lb. a minute. Therefore, the total weight of steam flowing through sections E and F will be $200 + 230 + 300 + 85 = 815$ lb. a minute. From the table we find an 8-in. standard pipe will be about right for the above conditions. The velocity in the 8-in. header, at points E and F, will be $815 \times 8000 \div 1010 = 6455$ ft. a minute, only during such conditions of operation as outlined above. Ordinarily the velocity in any section of the main header, will be less than 4000 ft. a minute.

If for any reason it is found desirable to use a larger header, a 10-in. pipe should be selected in preference to a 9-in. pipe, as this is an odd size; 3½, 7, 9 and 11-in. pipes are odd sizes and are seldom used without first making sure that pipe fittings and valves, to match, can be readily obtained on the market when desired.

In Fig. 1 the main steam header could be reduced in size, at each end, but in a plant arranged as shown, it is not customary to do so, as the headers are seldom very large in size.

In Fig. 2 the boiler and engine rooms are placed end to end and the steam flow in the main header is all in one direction. In this case it might be advisable to step the header down as shown. The pipe sizes were worked out from the table and are the nearest sizes to suit the conditions. In Fig. 1 an 8-in. header proved of ample size for the heaviest draft of steam, whereas in Fig. 2 a 12-in. header is required. This is necessary, as the steam from all 6 boilers must flow through the 12-in. header before reaching the nearest engine branch. In this case the area of the main header may be made to equal the approximate aggregate area of the boiler branches supplying it.

For example: The boiler branches are of 5-in. pipe, having a sectional area of 20 sq. in. each. Then section A of the header should have a cross-sectional area of $1 \times 20 = 20$ sq. in., section B should have an area of $2 \times 20 = 40$ sq. in., section C, $3 \times 20 = 60$ sq. in., section D, $4 \times 20 = 80$ sq. in., section E, $5 \times 20 = 100$ sq. in., and section F should have a cross-sectional area of $6 \times 20 = 120$ sq. in. If it were possible to

proportion the system to exact areas, as above, the velocity would be uniform throughout the system, this is not possible, however, therefore the nearest size standard pipe should be selected in each case.

Allowance for Machines Running Intermittently

WHEN estimating the total weight of steam flowing through the header in a given time, care should be taken to make proper allowance for pumps, engines, and other machinery that may run intermittently, such as winding engines, elevator pumps, conveying and hoisting engines, etc. For example: Assume elevator pumps, Figs. 1 and 2, to be 15-hp. pumps, taking steam full stroke. Assume only 1 pump to be in operation, consuming, say, 150 lb. of steam per horsepower per hour if run continuously. Each pump, operating, say, 20 min. an hour, or $20 \div 60 = \frac{1}{3}$ of an hour, will require $15 \times 150 \times \frac{1}{3} = 750$ lb. of steam an hour, whereas if run continuously they would require $15 \times 150 = 2250$ lb. an hour each. This should also be taken into account when estimating the boiler capacity required for a given plant. For pipe lines under 100 ft. long, it is seldom necessary to take account of pressure drop or friction losses. For longer lines however, and where the steam flow is retarded by the use of numerous bends, elbows and other sharp turn fittings, it is advisable to estimate the line for friction loss and pressure drop, as will be explained later.

BURNING CRUDE OIL

Changing from Coal to Oil Furnace to Increase Capacity, Difficulties Encountered, Systems Tried Out, Results Obtained

By John Pierce

SOME time ago I wrote a little article for Practical Engineer, in which I requested information from engineers in regard to crude oil burning. I think that I should also have given my experience along that line, but as I omitted this, I'll see what I can do at this writing, and so, perhaps, save some of them the trouble of fitting up, and trying out, a good many of the so-called systems.

Four years ago, I, after much persuasion, induced my firm to put in an oil burning system, as we were burning the poorest kind of coal, and even that cost us $2.60 per ton, in the bin; and as we were running to the limit of our boiler capacity, I thought I could save the price of a new battery of boilers, by changing to oil for fuel. In that I succeeded, for as yet we have been able to produce all the steam needed, though our load has doubled. Let me mention that this is a big item when floor space is valuable, and in a city where they have the smoke law, it also saves a mechanical stoker, and its attendant repair bills.

After the firm agreed to pay the bills, I had 2 cisterns dug, walling them with brick, with 1 in. of rich cement surfacing. The combined capacity of the two is 45,000 gal.

I dug two of them, in order to be able to clean them, for having had experience in going into oil tanks, I didn't feel safe in trying to run with one cistern, for crude oil will deposit more or less gumbo in the bottom, and in time it must be removed. As we keep current on the lines continuously, I could not let my cistern, providing I had but one, go entirely empty, and so built two.

Next, I made a set of coils, and placed them just beneath the suction of my oil pumps, and connected to steam header with ½-in. steam lines. Having ordered 2 watch charms, better known as Marsh No. B, steam pumps, I proceeded to make my pumping system. I sent to Chicago and had 200 ft. of ½-in. pipe bent into a coil 12 in. in diameter, which I placed in an old range heater. I use the exhaust from oil pumps through this, and get 200 deg. F. on my oil.

Then came the question of burners. After giving the matter much thought, I decided on the Higgins burner, since it throws all its flame to the side walls, and where one is using dirty water, making lots of deposit, this class burner never burns the bottom of the boiler, even though there may be a great deal of scale piled up there. I used at first, only 6 lb. pressure on my oil and 100 lb. steam pressure. I used the Higgins blue print for arranging my furnace, which calls for grate bars left intact, simply supplying air for burners, through a space 5 in. long, lengthwise of the grates; the space for 18 in. in width directly under the burner being closed, and the balance of the grates being air tight. The damper was kept about ½ closed, and no air entered through the ash pit doors.

At first I did not make the old fire door space air tight, but merely set loose bricks in the openings. Well, the burners were not content with being cheated out of what air they needed, and the explosion, though small, kicked the bricks out, and then the concussions nearly shook out all the boiler room windows.

But I was learning, so I opened the ash pit doors, which made them behave a lot better, and plastered up the bricks in furnace doors, leaving a place to insert torch, and to get a "look in" now and then.

Proper Mixture

BUT the next thing that happened, was that on easing down my oil, I didn't ease the steam side also, with the result that the steam forced out the flame, allowed the furnace to fill with gas, and then, as my night man said, she "combusticated" with a great and generous noise, and lots of smoke on her part, and, on mine considerable profanity, for the back arch had left its happy home, and gone to that bourne from whence no back arches return.

I hunted about, and located some old cast plates, which were just the thing, and in a very short time I had that alright. Still learning. Higgins' burners call for a blue gaseous flame, and, after a while, I learned the proper proportions of air, oil and steam to give it. It makes a great fire, but is more costly than coal, though, as I said, it doubles the boiler capacity.

Some Experiments Tried

THEN we investigated, and everyone that came along had a different, a better way to use crude oil. So I wrote down each one's theory, and would try it out, one week to each theory. I traveled myself, and my firms' president traveled, looking for "the" way, but failed to find anything any better than our own. We experimented for 2 yr., as I said, one week at a time, and finally went back to the old Higgins style. This had the one advantage, that, while it was practically the same as regards cost of fuel, it was noiseless, and the others were awful, and believed in letting you know they were busy.

We tried, among the many systems, one in which we set the bricks V shaped, over the entire grates, letting air in at all points, as the bricks were ⅛-in. apart; we lowered the grates, in another system; we

tried another, in which we used hot air, and finally we took out the grates, and shot the fire down into the ash pit; we closed the dampers, more and less; we piled the back end of furnace and combustion chamber full of brick bats; we tried cold oil, hot oil, and some that wasn't oil at all; we used a set of checker worked bricks, and we used deflecting walls. In fact we did any thing, and every thing.

As I stated in my other letter, this college man over in Oklahoma, says he has it. Next month I'm going over and see what he has got. In Practical Engineer, March 1, a professor in Texas says he found it. I'm going down and see what the dream of the professor has resulted in, and how he did it.

Our boilers are clean, our flues are kept clean, our system doesn't soot the flues, and doesn't smoke, our flame is cut off just short of rolling point, our walls are tight, and our oil is good. Yet an average of 8 gal. of water to one of oil is the best I can do. It is remarkable, however, that in all my tests, my flue gases have remained practically the same. I have oil meters, and checking meters to check the main meter, water meters, with their check meters, and about everything that I could have, in order to help the cause along, but I can't get better than above results, no matter what I do. Of course, lots of these tests did not give nearly as good results as the above.

Running Without a Stack

BUT a few days ago my stack, which was 100 ft. above the boilers, blew down, and so I thought, just thought, that I was down and out, as the stack went to pieces, and crumpled up. But there is where I thought wrong, for after considerable experimenting, one has to experiment, I found that by having hardly any draft, and by leaving my pit doors open, and the furnace doors open just enough to give the flame a short, bright, snappy appearance, that I get better results than ever before. I now evaporate 9 gal. of water per gallon of oil, and pull nearly as much load as formerly. So, instead of ordering a new stack, we sorted out several joints of the old one, and next week will put up a 25-foot stack, which, I think, will allow me to pull equally as much as before, and give me better evaporization results.

Then I have in mind, one other experiment to make, along the lines of converting the oil to a perfect gas, before it reaches the burner, and I figure that I can do away with the steam side of the burner, after it once gets hot enough to generate the gas. I would be glad to learn of any tests that have been made with the Nelson burner, and what results have been attained. With the last named system, I am feeding oil at 30 lb. pressure, and but very little steam, on the steam side of the burner. I put a blower in the breeching at first, but only used it about 10 min., when I discovered that it did more harm than good, and so have not used it since then.

Of course, if any of the readers can tell me a better way of burning crude oil, I will be glad to try out their ideas, and if they hold good in my case, shall give him the credit of it. I am for saving as much of the firms money as is possible, for it happens that I work for a company that is willing, and does, increase a fellows wages in proportion to the increased ability shown.

In the first part of my letter, I mentioned the fact that I put a coil under my suction foot valve. A good many will probably wonder the reason for this. But we sometimes get a car of heavy fuel oil, and in cold weather, this oil won't lift, and so by sending a little steam through the coils, directly under suction, the hotter oils, leaving the pipes go up, and so I get my oil thin enough to pump. I simply don't heat the oil, but just keep it warm enough so that that which is directly at the suction stays thin.

There is another firm a block away, whose engineer in charge failed to make any provision for this, and so for several months was down about ¾ of the time. And, seriously speaking, why doesn't some one, who knows, write a good plain language book on oil burning, for in all my traveling over the United States, looking for a better means of using oil, as fuel, I find that 95 per cent of the engineers would welcome one as they, like myself, are using the best ideas they have, but unlike myself, are not so fortunate in having a firm that is willing to spend money in making tests. Let us hear from some of the comrades.

AN ENGINEER'S SOLILOQUY

On an Offer of a Job Installing a Water Power Plant and the Uncertainties of Moving

By The Rover

ABOUT that dam (—) job out at Flowover,—yes, I suppose that it will be a great experience for anyone but,—IT ISN'T AN ENGINE. Nothing interests me unless it is an engine. This matter of lugging around a shaft that weighs 50 tons or so, why I have had all of that that I care about when I was with the Engine Co., and as for the whole thing when it is completed, while it is a big undertaking, it means no more to me than a lift bridge, and as it runs with water, that is along the same line as a lawn sprinkler.

A waterwheel may be all right and all that, but you can't take an indicator card off it or set the valve, or equalize the cutoff or any of those things. All you can do is to turn on the juice and let'er slide. Of course, the governor is a very delicate and interesting piece of machinery and all that,—but I do not care to go out there and paddle around in the Muddy Slop River, even at $5 a day.

Now that Super out there is a regular "moving picture." He thinks nothing of picking his family up and carting them off over the country every little while, or even, as in the present instance, wiring for them to come at once. He has crates made for all of his furniture like a sewing machine, or a selfbinder, and when it comes to move, it is simply a case of crating up and phoning for the dray, or else phoning first.

I have been married now 13 yr., and have only moved 200 ft., and it cost us just $1.50, and I said that it was going to be the last time we moved unless the job was a bully good one, and I don't call a job of 12 to 16 months, even on a big water top, a good job, when that is all there is to it, and someone else does all the brain work. When you get through, it is a case of look for another job. I have seen the base of a heating stove slid over the west exposure of an installment piano, and the hind leg of a settee ruthlessly thrust through the confines of a pier glass mirror (is that what you call them?) and,—none of that for little Willie.

I have got a few good things besides my wife, among which is a Steinway piano, and I do not like the idea of some ex-sailor standing on the keyboard with hob-nailed boots, driving with one hand and

with the other trying to keep the stove from getting familiar with the bay-window of the sideboard,—and not succeeding.

It has been my good-mis-fortune to see the worldly goods with which an industrious fellow engineer endowed his newly acquired spouse at the altar, stowed into the cavernous interior of a moving van and the chinks filled in with stovewood. Also have I seen these same goods in a miscellaneous assortment along the side of the road fully exposed to the invigorating effects of a gentle March shower, while the industrious driver and his understudy in crime endeavored to place their gondola on the tracks with the assistance of the bedslats, using the caneseated chairs for blocking at intervals to hold what they had till they could lift a bureau into a better position to pry on.

I once saw a small sized box car standing at an acute angle in front of a wayside tangle-foot dispensary, just over the line from a local-option county. The winter's day was fast drawing to a close. The setting sun had sot and the pale and trembling stars timidly pushed their sparkling heads through the mantle of night, while the glow that was seen in the east, proclaimed that the gentle moon would soon rise in all its glory, fuller'n a goose.

The farmer busied himself with his evening chores and his wife created a hungry zone of several miles radius with the fragrance and intensity of home-made ham-and-eggs. The merry jingle of the tinkling bell announced that Josh Wittenberry was on his way to take Safrona Higgins to the literary over at Hale's Corners in his new Portland cutter that he had just bought in Centerville with the proceeds of the wool off the sheep that Paw gave him 2 yr. before.

Within the gin-mill, the noisy loafers still told of wonderful happenings which occurred, unfortunately, when no one but the narrator was present to substantiate the claim. Sam Blodgett had just finished cutting and piling 2 verbal cords of wood (hickory, too, b'gosh), and Eph. Haverstraw was coming to bat with his time honored story about stringing a flock of wild geese on the ramrod of his trusty rifle, when the unmistakable whinney of a horse at the rail instantly stopped all conversation for the instant.

"Bill," said the driver, "did yer blanket them old plugs w'en yuh come in?"

"Naw! Didn't jah?"

"Naw, I didn't. G'wan out 'n cover them cripples up and be lively 'bout 't too."

Soon Bill stuck his head in at the door and asked in an uncertain voice:

"Jim. Oh, Jim! Whattidjah do with th' hoss blankets?" Jim rolled around, took a good look at his helper and asked in a voice that sounded like nails in a base drum:

"The hoss blankets? Wy, I aint seen 'em since yuh tuck 'em offen the old crowbaits down at Shads Corners thish affernoon."

"S-say, I tuck 'em offen the hosses down at the Corners all righ' 'a hung 'em over the hossrail an' tol' yuh to puttim in th' waggin."

The driver and his helper looked at each other for several seconds, and then tacitly passed outside, where they ripped up a $150 velvet rug to blanket a pair of $50 once was Percherons.

This is but a passing incident of the many that have come under my observation on the great and pressing subject of transportation of household effects.

They say that 3 movings is as bad as a fire. But from my observations covering about 13 years or so of more or less successful married life, I have come to the conclusion that 3 fires are as bad as a moving, if the fires are bad ones.

So about this situation, or even plain job, that necessitates my removal from a radius of 2 miles from where I eat, sleep and loaf, it has got to carry with it a monthly pay check that will make it cheaper for me to give my furniture and other junk to the associated charities, and go there and start all over again with a clean slate. No, sir. No moving for yours truly. I have moved but once, and from present observations, it is about twice too often.

ELECTRIC POWER CENTRALS

ERECTION of centrals for distribution of electric power among small towns and rural communities is making rapid progress in Saxony. The first establishment of this sort in the Chemnitz consular district was located last year at Oberlungwitz, some 10 miles from Chemnitz, near extensive coal mines. The central now furnishes 15,800 kw. power to 61 different villages and towns. The annual consumption of electricity reaches 5,260,000,000 kw.-hr. Of this amount 3,920,000,000 are used for power, 1,170,000,000 for lighting private houses and the remainder for lighting streets and railway stations. The daily consumption of coal reaches 20 long tons.

The 6 boilers are provided with automatic grates, each having 3770 sq. ft. of heating surface. Water supplied the boilers passes through a preliminary heater, in which the temperature of 120 deg. C. is reached. The steam produced is conducted into a superheater with 990 sq. ft. of heating surface, where the temperature is maintained at 360 deg. C., and passes to the turbines under a pressure of 14 atmospheres. There are 6 steam turbines, each of 1000 hp. and coupled directly with a dynamo. An alternating current of 3000 volts is generated and this is transformed into currents of 6000, 10,000, and 30,000 volts for transmitting lines. At local stations the voltage is reduced to 220 volts, for the immediate distribution to subscribers. The alternating current is further transformed to a direct current for use on electric lines.

Special provision is made against danger from lightning on the transmitting lines, by use of a jet of water which plays on the cable during stormy weather and establishes a ground connection for any heavy electrical discharge of atmospheric origin.

These centrals are now becoming so numerous that they are often connected with one another, in order to provide for mutual assistance in case of any accident to a generating plant. There are two other centrals in southwest Saxony, at Schwarzenberg and at Schweinsburg, at distances of not over 20 miles from Oberlungwitz. The 3 stations are now connected with each other by cables over which currents of 30,000 volts can be transmitted. Should any dynamo be temporarily disabled, it is usually possible to supply the lacking power by the combined contributions of the sister centrals.

The establishment of these centrals in western Saxony is of vast importance to a multitude of minor industries, chiefly of a textile nature, which require a small and variable amount of motive power. The freedom from dependence upon mountain streams with their uncertain supply, and upon steam engine plants, is a matter of considerable moment. It represents a marked step forward in economic liberty for a number of modest manufacturing undertakings.—Daily Consular and Trade Reports.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

MOULDING WIRING

Various Methods of Installing Electric Light and Power Wiring in Wooden Moulding

By Earnest B. Evans

WOODEN moulding wiring is frequently used for additions to existing installations and where a low-priced job of neat appearance is required. Its use is prohibited by the Underwriters' in damp places, in rooms where there are fumes, or in elevator shafts. Approved fittings are

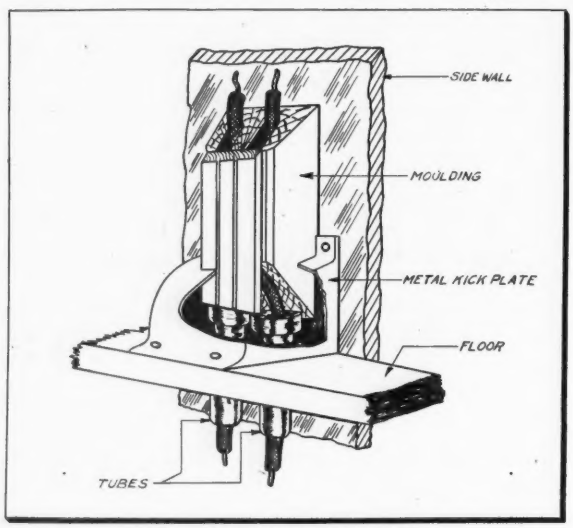


FIG. 1. MOULDING KICK PLATE

made whereby moulding wiring can be used in combination with the other methods. Double-braid wire, spliced to the single-braid moulding wire, must be used in the conduit. Where wire from moulding runs into flexible tubing or loom, single-braid wire

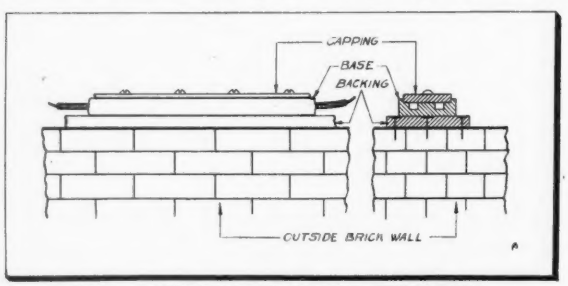


FIG. 2. MOULDING ON OUTSIDE BRICK WALL

may be used in both moulding and flexible tubing.

Standard designs of wooden moulding, two-wire and three-wire, are shown in the Practical Reference Tables with dimensions. For first-class work hardwood moulding and capping, matching in finish the trim of the room in which it is installed, can be used with capping of various designs but in all cases it should conform to Underwriters' Code requirements. Poor material which is cross-grained or knotty, should be avoided, because it will be more expensive in the long run than first-class stock.

Patented mouldings are obtainable, which will retain the wire when it is pressed into the grooves, making the use of brads for temporary support unnecessary. Although it is recommended by the Code, hard-wood moulding is little used; Georgia pine, oak, or similar hard-wood mouldings cost about twice as much as the ordinary white wood stock.

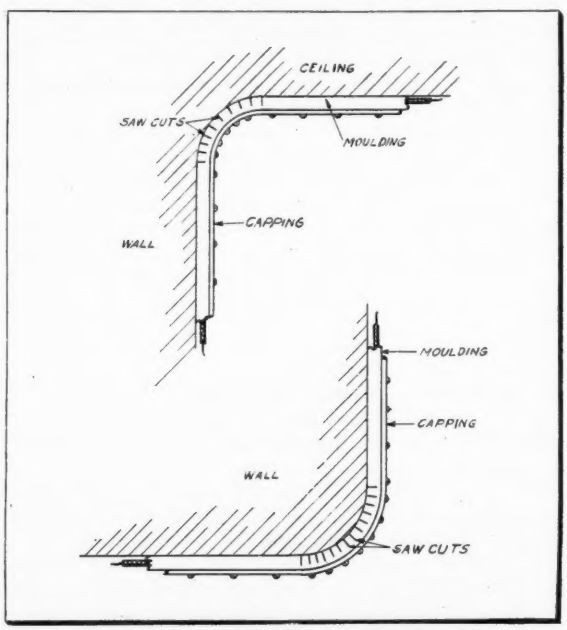


FIG. 3. BENDING MOULDING

Moulding is supported on lath and plaster with long, small diameter, flat-head screws; nails are permissible when running over a wooden surface. On brick walls the wall is drilled and plugged and a wood screw turning into the plug supports the moulding; in fire-proof buildings on hollow tile partitions and arches, toggle bolts are used. Wood screws have been used for this work by drilling holes in the tile slightly smaller in diameter than the screw, then turning the screw into the hole causes it to cut its own thread.

Moulding base should be supported every 1½ ft. to every 3 ft., and the capping somewhat more frequently. With very large moulding, supporting points should be even closer together.

Screws or nails can be used to support capping and they should, if possible, pass through the capping and base into the wall. Where 2 pieces of base join they should be cut on an angle, so that one piece will support the other. Where feasible, the nut on a toggle-bolt should be placed outside the capping; if

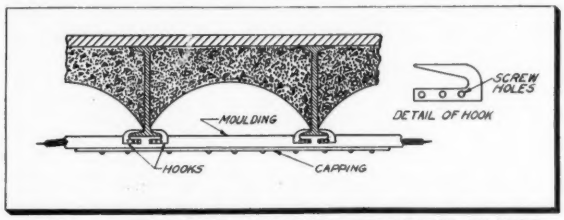


FIG. 4. MOULDING ATTACHED TO I-BEAM FLANGE

placed under the capping there is a possibility, particularly with the smaller mouldings, of cutting away so much of the tongue that the toggle-bolt nut will bridge across the conductors.

When erecting wooden moulding on side walls or partitions, it should never be installed where it will be subjected to mechanical injury, and as a general proposition should not be used within 6 ft. from the floor; conduit or pipe protection is preferable in such locations.

In running moulding circuits through floors where no interference is probable, the moulding can be run almost to the floor, provided protection, such as a kick plate shown in Fig. 1, is installed at the floor. This construction is permissible in residences, offices and similar places. An iron pipe may be used instead

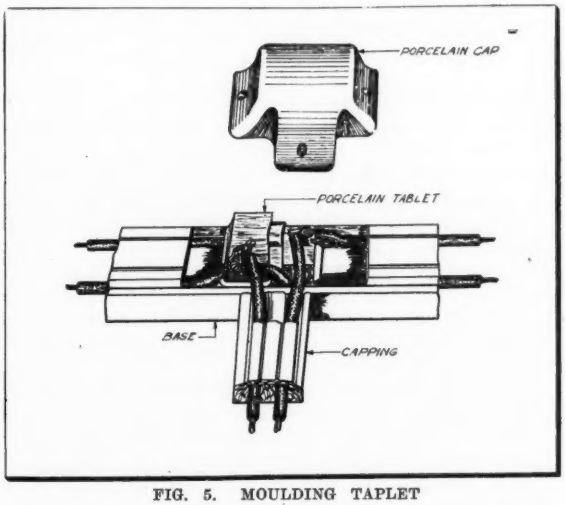


FIG. 5. MOULDING TAPLET

of a kick plate to protect wires from moulding where they pass through a floor, provided the wires within the pipe are encased in loom. The pipe should extend 4 to 6 in. above and below the floor.

When running wooden moulding on outside brick walls, a cleat or backing of wood ½ in. or ⅞ in. thick, thoroughly painted with a moisture proof paint, should be first nailed to the wall, Fig. 2, to which the base can be fastened. The backing protects the moulding from the moisture which often exists in the outer walls of brick buildings.

At turns, moulding should be mitered; a fine tooth miter saw and a miter-box, preferably a metal one, can be used to advantage. Moulding can be bent around the curved surfaces often found in modern office buildings, as shown in Fig. 3, by making saw cuts in the base with the miter-saw; moistening the base and capping makes the wood bend easier. Glue painted into the saw cuts, before the base is formed to position, will tend better to hold the base in shape.

To support wooden moulding to the lower flanges of I-beams in fire-proof and structural steel buildings, I-beam hooks, Fig. 4, punched from steel metal, are used, wood screws passing through the hook enter the base to secure them in position. Where the span between beams is long, it may be necessary to support a running board with the beam-hooks and then fasten the moulding to the running board.

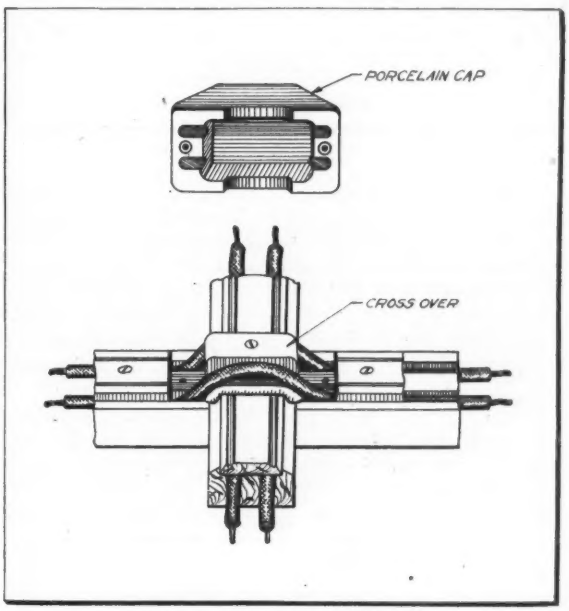


FIG. 6. MOULDING CROSSOVER

In tapping off a branch in wooden moulding wiring, an approved "taplet" fitting, Fig. 5, must be used. It was formerly permissible to solder on the tap wires and bring one of them over the capping, but this is no longer permitted by the Underwriters. No joints or splices are permitted in moulding wiring, except at outlets or fittings. A cross-over in wooden moulding wiring is made with a fitting as shown in Fig. 6. A joint in wires in wooden moulding must be made with an approved fitting, as shown in Fig. 7. No joints or splices are permitted within the moulding itself, the wires must be continuous from outlet to outlet.

In wiring for side wall outlets in a moulding installation, the moulding can often be advantageously carried around the baseboard and the taps to the outlets carried down within the partition in loom. The taps are fished down within the partition. Special compact fittings are made for connecting conduit circuits to moulding circuits, which can be substituted for the bulky and unsightly pressed steel outlet boxes.

In carrying wires from conduit to moulding, the single-braid moulding wire must be spliced to the double-braid conduit wire within an outlet box, as shown in Fig. 8. Flexible conduit or porcelain bush-

ings must protect the moulding wires where they enter the box. Where the junction between moulding and conduit systems is on a wall or ceiling wherein the conduit is embedded, the connection may be made as at B. An additional outlet box is attached over the old one with long screws.

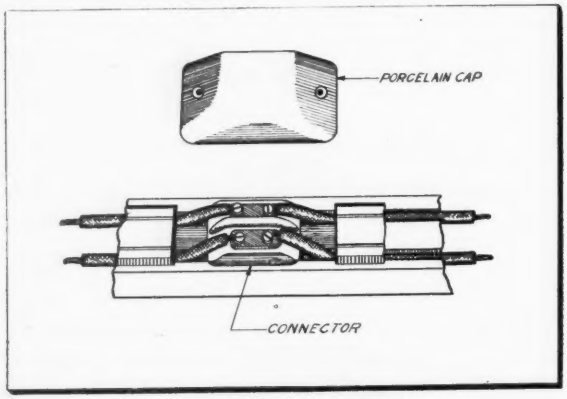


FIG. 7. MOULDING CONNECTOR

When using moulding in combination with flexible conduit or flexible steel armoured cable for old building wiring, flexible tubing or steel armoured conductors are used for the portions of the installation where they can be readily drawn in and moulding is used for the rest of the work. Where flexible, fibrous conduit and moulding are used, steel outlet and splice boxes are not required, so the work can be economically done and it looks well when finished.

Moulding receptacles and rosettes should be of the types for which the backing does not have to be cut for their installation; fittings are on the market which require the cutting of the backing and these should be avoided. Switches for moulding are ordinary snap

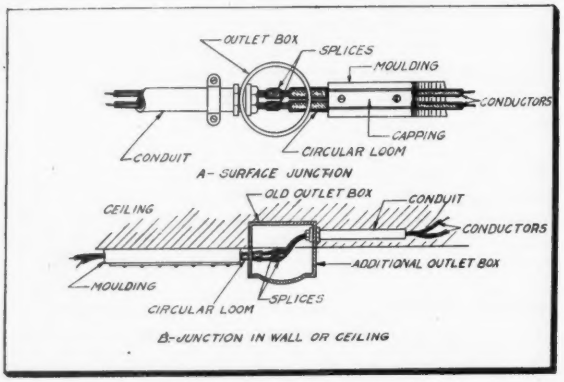


FIG. 8. MOULDING CONDUIT JUNCTION

switches, mounted on either a wooden or a porcelain switch block. Porcelain is preferable, but a wooden block can be made on the job if a porcelain block is not available.

In wiring in moulding for drop lights on a fireproof ceiling, if the panel has no directory, it is necessary to lay out a diagram of the circuits and tap the outlets in such a manner that the 660-watt limit per branch circuit is not exceeded. When estimating on such work, the wireman should ascertain the capacity of the existing outlets, so that his estimate will include any additional circuit runs to the panel that may be required.

Fixtures in moulding wiring installations should be supported on a wooden block about 5 in. in diameter. The block provides a substantial support for the fixture, constitutes a backing for the canopy and the wires can be carried through the block, eliminating the necessity of cutting the canopy.

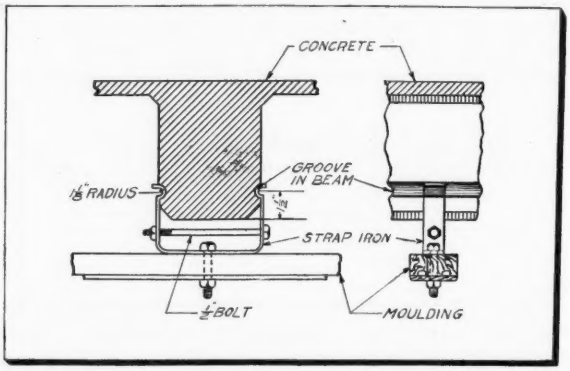


FIG. 9. SUPPORTING CONDUCTORS IN CONCRETE BUILDINGS

In Fig. 9 is shown a good method of supporting wooden moulding in re-enforced concrete buildings. For this method, however, a half-round groove must be cast in the sides of the beams, which is readily done if anticipated. A clamp, formed from strap iron and held in position with a bolt, holds the device; the moulding is then secured to the clamp with a stove bolt.

LIGHT, ITS USE AND MISUSE*

TO see easily and comfortably you must select the lamps, fixtures and globes and arrange the lights so as to suit best the particular conditions which have to be met, but certain principles which must always be followed may safely be laid down.

Judge the light you are getting by the way it helps you to see. Do not think because a lamp looks glaring and brilliant that it is giving you good light. It may be merely giving you too much light in the wrong place. On the other hand, a well shaded table lamp may look dim because it is well shaded and still be giving first-class light for working purposes.

You must get enough light to see by, and as you see things chiefly by the light which they reflect, it is evident that dark colored objects which reflect light badly require more light than do light colored objects to see them comfortably.

It is bad to have an unshaded brilliant light glaring into the eyes, for it throws hard labor upon them in an effort at adjustment. While artificial light may be made a good substitute for daylight, you have constantly to beware lest rays that are too bright, either from the lamps or from their reflections, hurt the eyes. You can get reflections, so bright as to be harmful, from polished metals or glass, from bright varnished surfaces, or even from glossy white paper upon which the light falls.

A bright light fairly in the field of view means a very brilliant light on the retina, producing fatigue. Everyone knows the blinding sensation of looking at the sun with its sequence of dazzling colored images.

However good and suitable the lamp, it will be put at a disadvantage unless the lighting fixture which

*Abstract from a primer by Illuminating Engineering Society.

carries it is designed to hold the lamp in the right position to enable one to best utilize the light which comes from it.

Daylight is naturally well diffused; but artificial light, poured out as it is from mere points, or narrow surfaces, needs to be tempered or softened by shades. And it sometimes further requires to be directed upon a desk or table or other object. In some cases it is better to adopt indirect methods, and throw the beams of a lamp upon a ceiling whence the rays are scattered. For every particular need there is ample provision amid the abounding lamps, globes and reflectors of present day designers.

REVIVING DRY BATTERIES

By Martin McGerry

ACCOMPANYING sketches, Figs. 1 and 2 show how to recharge dry cells which have run down through excessive use or through standing idle for a lengthy period of time. The cells may be connected, as shown in Fig. 1, using an incandescent lamp for resistance, or as shown in Fig. 2 using a water resistance.

If the wires A and B are submerged in a dilute solution of salammoniac, gas will be given off in considerable quantities near one wire; this wire should be connected to the carbon terminals of the batteries. Current should be allowed to pass through the cells

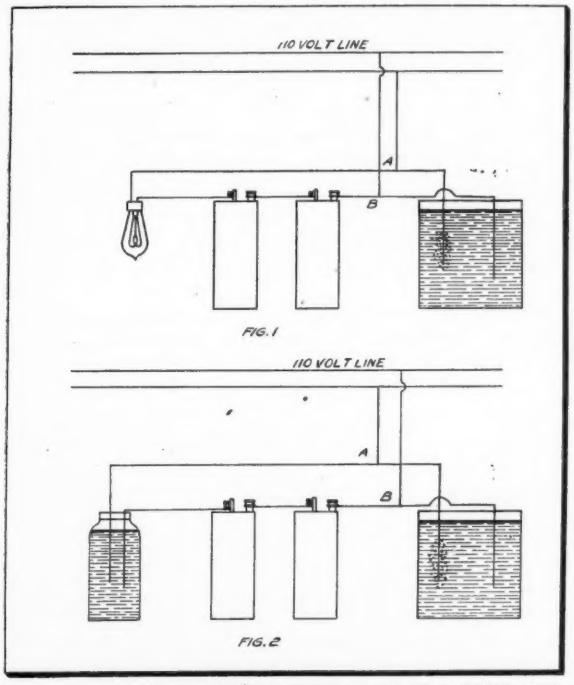


FIG. 1. BATTERIES CONNECTED WITH LAMP AS A RESISTANCE
FIG. 2. USE OF WATER RESISTANCE

for a half hour. It will be found helpful if a hole is made in the wax filling at the top of the cells and the cells submerged in water for a few minutes before the current is applied.

Editor's Note

MR. McGERRY and many others labor under the misapprehension that dry cells can be revived by passing a current through them. This is not the case, however, as it has no effect on the batteries, the addition of water to the cells being responsible for bringing them back to activity if they are not too badly depolarized. The dry cell consists of a jar, generally of zinc, which forms one electrode. The carbon electrode is suspended in the center of the zinc vessel, care being taken not to allow it to touch the zinc. The zinc is protected by several thicknesses of blotting paper and the chamber filled with a mixture of carbon, manganese dioxide and sawdust, or some absorbent substance, the mixture being saturated with a solution salammoniac. The top is sealed with wax and the whole cell slipped into a pasteboard box.

The term dry cell is rather of a misnomer and undoubtedly came from the fact that the cell is sealed so that no fluid can run out. In long standing the solution will gradually dry out and render the cell useless until water is added.

Another cause for a battery running down is polarization which is prevalent to a greater or less extent in all cells. The decomposition of the electrolyte (salammoniac solution) in the cell liberates free hydrogen which collects on the surface of the negative or carbon element which enormously increases the internal resistance and diminishes the e.m.f. of the cell. It should be stated that the carbon element of a battery is positive electrically but negative chemically, as the electrolytic action in the cell is from the zinc to the carbon.

The manganese dioxide in the cell is rich in oxygen which unites with the liberated hydrogen and forms water; the energy liberated by such formation adds to the e.m.f. of the cell. Continued hard usage will cause polarization to such an extent that the cell becomes inoperative.

A MIDWINTER CONVENTION of the American Institute of Electrical Engineers is to be held in New York, at the Institute headquarters, 33 West 39th St., Feb. 26-28, 1913, under the auspices of the Standards Committee, This meeting will be devoted to the general subject of the rating and testing of electrical machinery and apparatus.

Members are invited to contribute for this convention papers and discussions dealing with the following subjects:

1. Methods of determining temperature of apparatus, room temperature, and correction of temperature rise for room temperature, humidity, barometric pressure, etc.

2. Methods of determining losses in apparatus, including: Load losses, their determination and approximation. Commutation or brush losses, their determination, approximation or calculation.

3. Methods of testing apparatus under conditions equivalent to specified performance.

4. Guarantees and permissible variations therefrom.

5. Miscellaneous subjects connected with rating and testing, such as insulation tests, high-potential test and spark-gap standard, permissible variation of wave shape of alternators, control apparatus, rheostats, heating devices and sundry other subjects.

It is desired that these papers contain data and constructive criticism, giving definite recommendations for the guidance of the Standards Committee in the revision of the Standardization Rules, rather than general theoretical investigation and discussion.

All those desiring to contribute papers for this convention should notify the chairman of the Standards Committee as to their intention immediately upon receipt of this notice, and all manuscripts must be received at Institute headquarters on or before Jan. 1, 1913.

F. L. Hutchinson, Secretary.

PRACTICAL ELECTRICAL ENGINEERING

Single, 2- and 3-Phase Rotary Converters, Substation Connections, Regulators

ESSENTIALLY, a rotary converter is a synchronous motor and direct-current generator built as one machine with a commutator on one end of the armature and collector rings at the other end. Primarily, such machines were designed for converting alternating current into direct current, but,

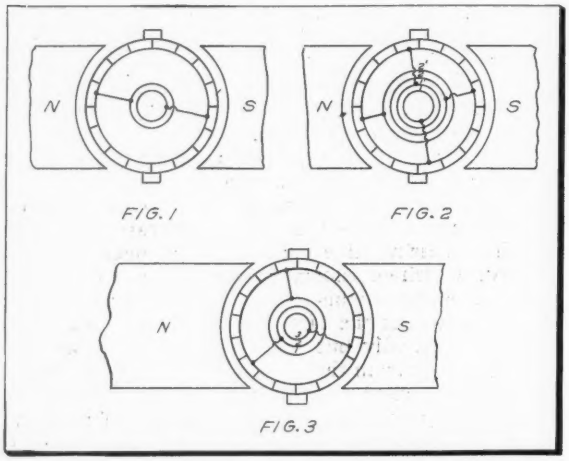


FIG. 1. SINGLE-PHASE ROTARY CONVERTER CONNECTIONS
FIG. 2. TWO-PHASE ROTARY CONVERTER CONNECTIONS
FIG. 3. THREE-PHASE ROTARY CONVERTER CONNECTIONS

in some instances they are made to convert direct current into alternating current; under such conditions of operation, the name inverted rotary converter is frequently used.

In all rotary converters, the commutator end has the same purpose as a direct-current generator and 2 or

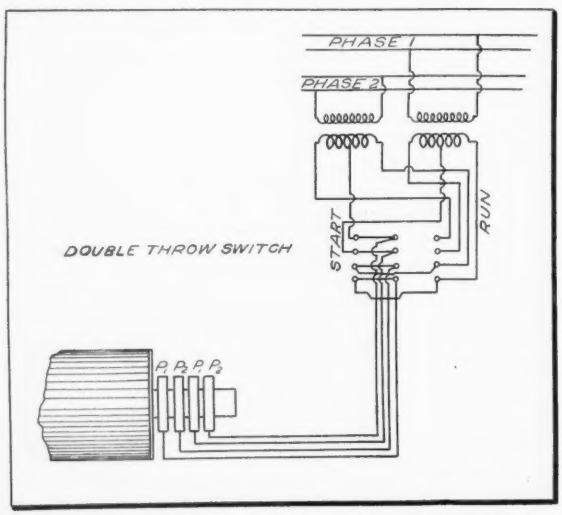


FIG. 4. METHOD OF STARTING ROTARY CONVERTERS DIRECTLY FROM THE ALTERNATING-CURRENT SIDE

more machines may be operated in multiple from the direct-current side or arranged to operate a 3-wire system. Previous articles on the subject of direct-current generators have given sufficient information to cover the direct-current characteristics.

The alternating-current side of a rotary converter should be considered as a synchronous motor. Refer to article entitled "Synchronous Motors" (Practical Engineer, June 1, 1912, page 574).

If, under normal conditions, the rotary converter be excited to give an e.m.f. less than that of the system, when it is running at the speed at which the alternations of the supply require that it must run, a lagging current will be drawn from the system, which current tends to strengthen the motor field so that the generated e.m.f. is made to equal that of the system. If the field be overexcited, the current drawn from the supply mains will be leading, and will thus demagnetize the field sufficiently to make the e.m.f. equal to that of the system.

There is always a definite ratio between the voltage on the alternating-current side and the voltage of the direct current side. Considering the desired direct-

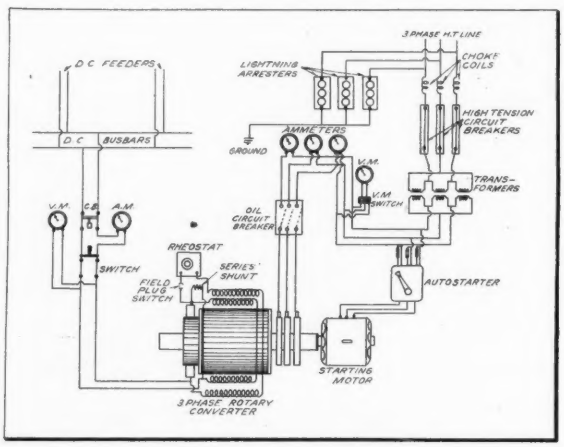


FIG. 5. SUBSTATION CONNECTIONS FOR A SINGLE 3-PHASE ROTARY CONVERTER WITH STARTING MOTOR

current voltage as 500, the required alternating-current voltage will be, for single- and 2-phase circuits, $500 \times 0.71 = 355$ volts; for 3-phase circuits the required alternating-current voltage is $500 \times 0.61 = 305$ volts.

Internal Connections

FIGURE 1 shows diagrammatically the internal connections of a single-phase rotary converter with 2 poles; a small number of poles are shown for the sake of simplicity. Taps are taken from the armature winding which are connected to the collector rings as shown. The outer divided ring represents the direct-current commutator and the inner circles the collector rings. In a single-phase converter, there are as many taps as there are polls, every other tap being connected to one ring, and alternate taps to the other.

In a 2-phase converter, Fig. 2, there are 4 collector rings, 1 and 1^1 being connected to phase 1, and 2 and 2^1 connected to phase 2. There are twice as many taps for a 2-phase machine as for a single-phase with an equal number of poles and the taps for phase 2 are spaced 90 electrical degrees behind those for phase 1.

Figure 3 shows the manner of connecting the collector rings of a 3-phase converter. The taps are so connected that they bear a relation of 120 electrical degrees.

Starting Rotary Converters

THERE are 3 general methods of starting rotary converters; A, by applying alternating current directly to the collector rings; B, starting from the direct-current side as a direct-current motor; and, C, by means of a separate starting motor.

Figure 4 shows the connections for starting a 2-phase machine by method A. A tap is taken off the center of the transformer secondary coils and by means of a double-throw switch, half voltage is applied for starting and bringing up to half speed, when the switch is thrown over to the running position. This method is applicable to polyphase machine only and has the advantage of requiring no auxiliary apparatus and furthermore, does not require sychronizing.

In Fig. 5 are shown the wiring connections in a single converter substation employing a separate motor for starting. With the converter oil circuit breaker open, the induction starting motor is started and the converter is brought up to approximate speed when it has to be synchronized before closing the main breaker. The manner of synchronizing rotary converters is the same as that for alternating-current generators which was explained in the articles entitled Synchronizing Alternators, which appeared in Practical Engineer, July 1, 1912, page 670, and Aug. 1, page 770.

Special Types of Rotary Converters

COMMUTATING poles as applied to rotary converters, fulfil the same function and result in the same advantages as in their more familiar application to direct-current generators and motors. As with

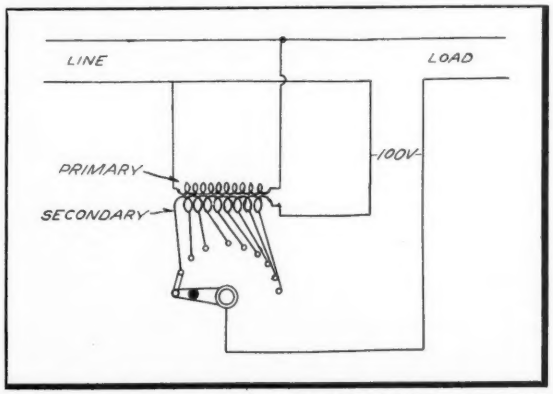


FIG. 6. CONNECTIONS OF REGULATOR FOR ROTARY CONVERTERS

the commutating pole direct-current generator, they insure sparkless commutation with a fixed brush position from no load to heavy overloads.

It is unnecessary to shift the brushes with change of load as the commutating winding is connected directly in series with the armature and holds the neutral position stationary. On account of this, it is necessary to have the brushes located at all times on the no load neutral point for good operation, hence no brush shifting device is supplied. The only difference in the application of the commutating poles to rotary converters, is purely in design. A rotary converter is inherently a better commutating machine than a direct-current generator as its armature reaction is much less, consequently the commutating pole coils have a fewer number of turns as less commutating field is required.

Commutating-pole rotary converters for railway service can be arranged for automatic compounding from no load to full load in the same manner as the noncommutating pole machine. They are particularly well adapted for railway service since the frequent peak loads can be taken care of without commutation trouble.

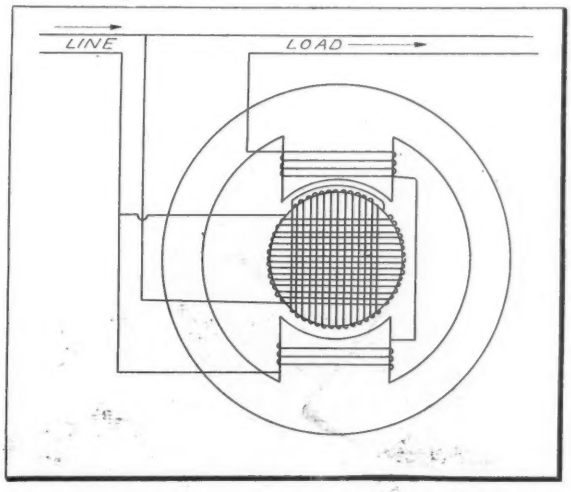


FIG. 7. CONNECTIONS OF INDUCTION REGULATOR FOR ROTARY CONVERTERS

Figure 8 shows a commutating pole rotary converter.

Synchronous booster rotary converters were fully described on page 722, of July 15, 1912 issue of Practical Engineer.

Voltage Regulation

IT has been pointed out that a definite voltage ratio exists between the alternating and direct-current sides of a rotary converter, therefore, to change the direct-current voltage it is necessary to change the impressed alternating-current voltage which is accomplished by means of regulators. Fig. 6 shows the connections of a single-phase regulator which consists of a transformer whose secondary coil is connected in series with the line and the primary coil connected across the line.

The secondary coil has several taps connected to contacts and by means of a switch lever the secondary voltage can be added to that of the line, the value being determined by the number of turns connected in circuit through the medium of the switch.

Figure 7 shows the connections of an induction type regulator for single-phase circuits; it consists essentially of a transformer having a movable primary coil so arranged that any desired portion of the magnetic flux set up by this coil may be made to pass through the secondary coil. The magnetic flux of the 2 coils may coincide with or be opposed to each other. A stationary cylindrical shell or core has 2 inwardly projecting poles on which are placed the 2 secondary coils connected in series with the feeder circuit to be controlled. A movable cylindrical core is arranged so that it can be turned through an arc of 180 deg. between the 2 poles on which the primary coils are wound. The relative angle between the

normal position of the rotor and any given position determines the relative effective regulation. In other words, the voltage generated in the secondary varies with the mechanical position of the rotor, but the voltage at all times remains directly in time phase with, or in time phase opposed to, the primary e.m.f. Thus the resultant delivered e.m.f. is equal to the arithmetical sum (or difference) of the primary and the secondary e.m.f., the latter depending upon the position of the movable element.

When the regulator is in use, even when the secondary e.m.f. is of zero value the secondary current may have full value because it depends solely upon

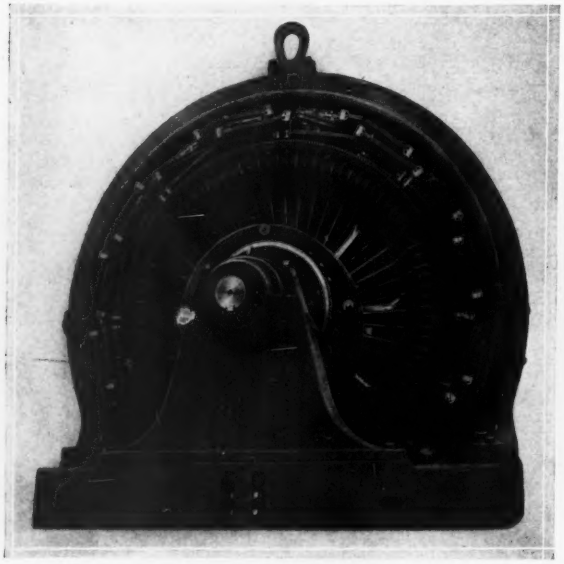


FIG. 8. WESTINGHOUSE COMMUTATING POLE ROTARY-CONVERTER

the delivered e.m.f. and the impedance of the delivery circuit. With the moving members in certain positions the magnetomotive force of the secondary current would be opposed in no respect by any primary current, so that a large value of flux would tend to interlink with the secondary coil and produce an enormous resistance therein. To overcome this defect there is placed upon the primary core in electrical space quadrature with the primary coil, a separately insulated coil which is electrically closed upon itself and forms a short-circuited secondary to the real secondary coil of the regulator which acts as the real primary coil.

Polyphase induction regulators are similar in construction to the single phase regulators with the exception that there are 2 shunt coils for a 2-phase system and 3 shunt coils for a 3-phase system.

ON AN AVERAGE a man dissipates about 2.5 kilowatt hours per day. This is spent partly in muscular action, partly in the production of heat in the maintenance of the body temperature against radiation. There is thus a continual power consumption of about 100 watts, or one-seventh of a horsepower. About one-half of this is spent in maintaining the body temperature. The human body has about the same heating effect upon the surroundings as a 16-candle-power carbon filament lamp.—Scientific American.

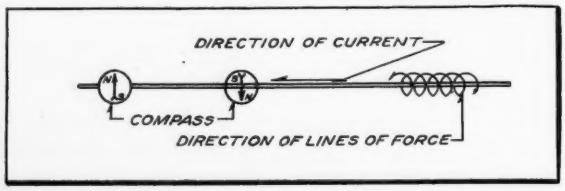
USE OF COMPASS

BY CHAS. BRACKEN

I WAS interested in an article which appeared in the Oct. 1 issue of Practical Engineer. I think there was one rule omitted which should have been given in the above article; it is in regard to the use of the compass.

In placing a compass over a conductor in which there is a current flowing, as in the sketch, the needle will be attracted by the lines of force as they circulate the conductor as shown by the arrow.

There is a little trouble in understanding the compass, but the old rule, unlike poles attract and like poles repel, makes it plain. Then the end of the



USE OF THE COMPASS IN FINDING DIRECTION OF CURRENT

compass needle that points north is the south pole of the needle or magnet; this must be remembered or there will be a misunderstanding in the use of the compass.

If one goes to work in a strange plant or on a line and wants to know the direction of current in the conductors, the compass is a great help. The more sensitive the compass, the smaller the current it will indicate, but applies to direct current only. If the current is passing in the opposite direction from that shown, the compass will point in the opposite direction, because the lines of force are reversed.

If one holds the compass to one of the poles of a generator the north pole of the needle will point to a south pole of the generator and the south pole of the needle will point to the north pole of the generator.

BASED ON AN EXPERIENCE of nearly 8 yr. the management of the Bessemer R. R. has determined that the steel tie holds the track to line and surface better at a less cost than the old wooden tie, that the track is always to gage and that rail wear is more uniform. Although the initial cost is about twice that of wooden ties, the Bessemer officials figure that when the tie is worn out entirely as a tie, they can regain part of the money spend by selling it as scrap, while that spent for the wooden tie is lost entirely. While they have no definite means yet of determining the length of life of the new tie, they believe that it will be about 20 yr.

Experience with steel ties under derailment is also instructive. About 150 derailments have occurred on such ties and about 1000 had to be removed because of damages resulting, a much smaller number than would be wrecked if the ties were of wood. While wooden ties often bunch up in a wreck, it has been found that the steel ties, in many cases, while injured, were not badly damaged but that they could be used in clearing away the wreckage without repairs at that time.

IN THE LONG RUN a man becomes what he purposes, and gains for himself what he really desires.—Hamilton Mabie.

VALVE MACHINERY FOR THE PANAMA CANAL LOCKS

Great Ships Held and Released Almost Automatically by Motor Operated Valves

By A. P. Connor

ONE of the most interesting features about the locks of the Panama Canal is that embraced in the system of valves controlling the inflow and outflow of water for the locks. It can be readily appreciated that the valves to control the flow of water through an 18-ft. tunnel must be of some consequence efficiently to withstand the strains placed on them.

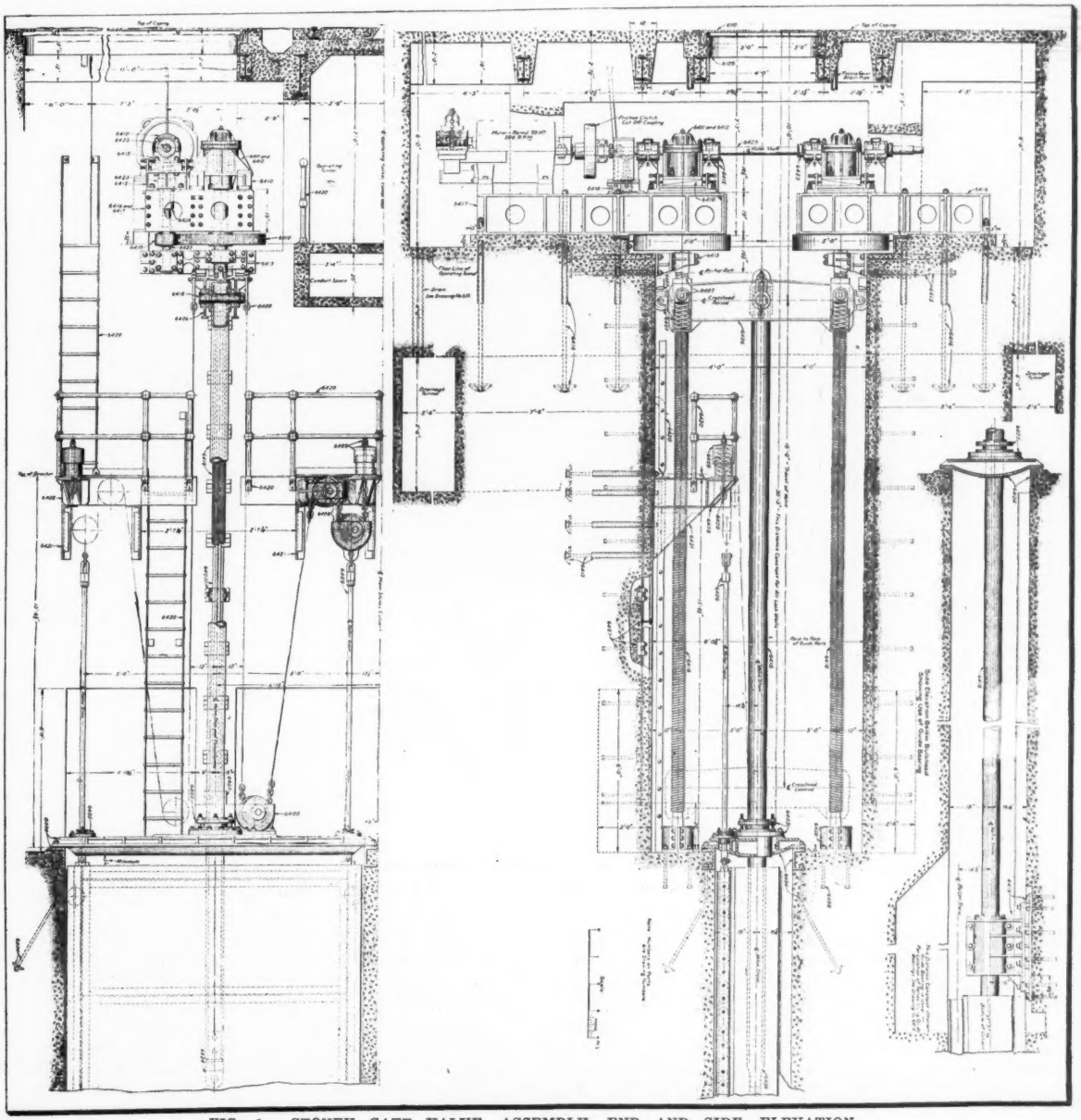


FIG. 1. STONEY GATE VALVE, ASSEMBLY, END AND SIDE ELEVATION

The locks are all built on similar lines and differ only in general dimensions and numbers of lifts. The locks are in pairs so that 2 ships may go through at the same time, and are only separated by a center wall. This center wall is longer than the sides of the locks as it is necessary to extend it some distance into the lakes so as to guide the ships properly into the locks. The length of this extension at each end of a set of locks is approximately 900 ft.

In all the walls of the locks there is a large main culvert approximately 18 ft. in diameter which provides the necessary water for the locks. Their ends are situated at the ends proper of the locks where they are controlled by the intake valves. Extending from the culverts under the floor of the locks are ducts 6 ft. in diameter which branch into the locks with 5 smaller ducts. The first mentioned ducts are controlled by cylindrical valves which are in turn

motor-driven. The arrangement of the ducts from the culverts is such that a row of ducts from the side wall culvert alternate with a row from the center wall culvert. In the Pedro Miguel locks, which is the smallest set on the Canal, there are 21 rows of branch ducts to supply each lock so that the number of holes through which the water enters each lock there is 105.

The operation of the valves is controlled by an operator in a special tower provided for him, who has a number of indicators in front of him telling him the height of water in the locks and lakes, the positions of the valves, and lock gates, and other necessary data to give him a complete insight as to the condition of everything pertaining to the locks.

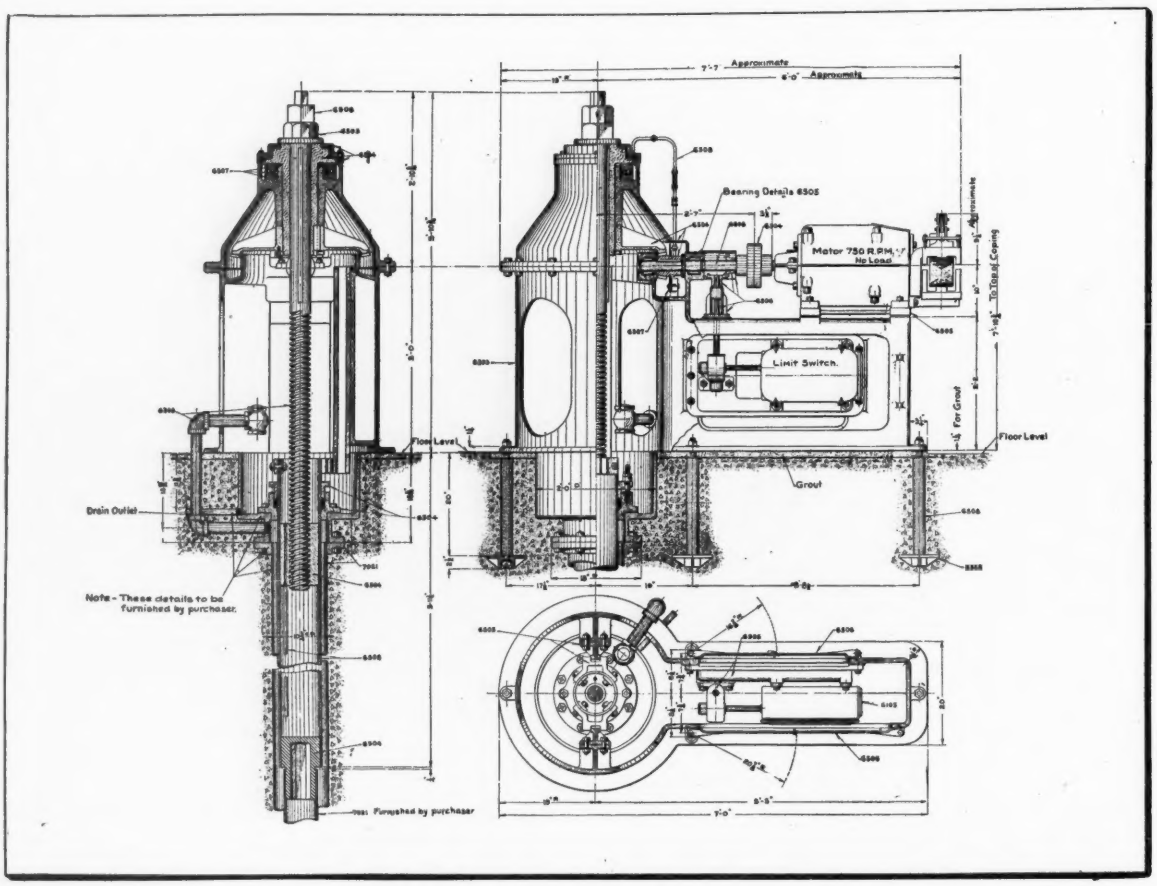


FIG. 2. CYLINDRICAL VALVES, ASSEMBLY AND SECTIONS

The operator in turn is prevented from making dangerous mistakes by a system of safety devices which control the parts that should not be operated prematurely.

After the ship is shut in the locks, and everything is ready to raise it to the next level, the intake or Stoney gate valves are opened and permit the water to fill the culvert, then the cylindrical valves in the side wall of the lock, and those in the center wall controlling the ducts for that lock, are opened and the water fills the lock and raises the ship. The gates are then opened and the ship is towed out of the lock by the electric locomotive provided for the purpose on the lock walls. The water is then kept in the lock until another ship comes along, when it is permitted to flow into the lock on the other side through the center ducts and cylindrical valves. This saves about half of the water required for the locks by using it twice over. When it is necessary to let the water flow out of the locks directly into the lower lake, the Stoney gate valves at the lower end of the culvert are opened also.

The intake or Stoney gate valves which close the main culverts are arranged in pairs in each culvert which for that purpose are provided with reduced U shaped ends. This reduces the size of the valve and makes it safer in every way. The valve may be said to be a large gate valve in principle, but with several additional features to make it capable of meeting the special conditions which arise in cases like the present. The gate is secured to a large stem which raises or lowers it, as the case may be, from the vertical valve seats it engages with, at the sides of the openings of the culvert. The travel of the valve is 18 ft.

A crosshead is fastened to the upper end of each valve stem which is drilled and tapped for 2 large square-threaded screws which are turned through suitable bevel gears by a 50-hp. motor. The screws in turning force the crosshead up and down, which actuates the valve stem and gate, and thus opens and closes the opening in the culvert.

A pair of roller counterweights attached to pulleys which permit their travel to be half that of the valves, assist the motor in closing the valve. These counterweights slide in the upper portion of the recess into

which the gate recedes, and are provided with rollers on which the valve gate slides when moving in the upper portion of its travel. Limit switches and other automatic safety devices are connected to the machinery positively so that the valve will stop at predetermined positions. The motors will open or close the valve gates in about a minute and will have to withstand a torque of 700 to 800 foot pounds on average occasions, but this may rise to 1300 foot pounds, as for instance, after a long period of idleness. From the above it will be noted that the load on the motor will be light during the operation of closing the valve. All the motors are of the squirrel-cage type, 220 volts, 25 cycles.

The cylindrical valves which control the branch ducts from the main culverts are operated by motors of 7½ hp., which are thrown directly on to the line, and will take about 11 sec. to open or close the valve. The mode of operating the cylindrical valves will be similar to that of the Stoney gate valve except that only one large screw will be turned by the motor, which will force a crosshead carrying the valve stem and valve proper up and down. Suitable bevel gearing attached to the motor-shaft and the limit switch causes the latter to turn with the screws and shut off the motor at the predetermined positions. One large casting in the machinery room near the top of the lock wall, supports the motor, limit switch, brake and housing for the upper portion of the valves. In order to keep the parts suitably lubricated a piping system for oiling is provided, which keeps all the parts that move well oiled and thus reduces the wear and frictional resistance.

An important feature in the valves is in the arrangement of their parts, which are designed so that a general inspection can always be made without trouble, and in case of necessity, easily removed or renewed. All of the valves that work together will have their motors connected so that one switch thrown by the operator will set them simultaneously to work. In the case of the cylindrical valves a multiple unit system will be used, and in the other cases remote control switches. When the various valves have reached the end of their travel, the limit switch will throw an indicator switch and connect it to close a circuit which lights a lamp. Two circuits are provided for this purpose so that a different lamp will be lit for each end position that the valve is in. The indicators for the Stoney gate valve will be progressive or synchronous so as to show to the operator their exact position at any time, and it is intended to make these indicators a small model of the valves.

In order to give the operator in the control house an accurate indication of the water level in each lock or part of lock when a difference of level may occur, and also of sea or lake level at either end of locks, wells are provided in the middle wall of the locks on each side of the center line and connected to the lock chamber on its respective side. The wells are 3 ft. square and rise above the highest water level, and are accessible from the operating tunnel which runs through the upper portion of the lock wall. The machine will consist of a float attached to a chain which connects with a device above which electrically transmits the position of the water to a vertical column at the switch-board in the control house, by means of a pointer and scale. The scale will be marked with divisions to indicate each 1/10 ft.

In addition to the valves referred to, there are several other sets of valves, principally in the main culverts, but these are rather of an emergency nature and will not for the present be provided with motors or devices as described above, and in case of necessity they will be opened or closed by hand.

The whole general scheme of the valves has been to give to the operator a complete knowledge of everything that is happening in the locks, and at the same time make the operation of the machinery quasi-automatic, and this has been so well worked out that it would seem as if a child could successfully operate the locks.

A ROTARY JET CONDENSER

In Which a Single Rotating Part Carries the Pump, Condensing Chambers and Ejector and Automatically Controls Delivery and Vacuum at Constant Speed

THE Rees RoTURBo rotary jet condenser, a recent type of jet condenser, was designed to retain the advantages and simplicity of the ejector condenser, with the economy and certainty of action of the barometric. The new condenser is a development of the Rees RoTURBo centrifugal pump, described in a recent issue, the unique feature of which is the employment of a revolving hydraulic accumulator or pressure chamber. In the case of the condenser this pressure chamber is used to lift the condensing water as an ordinary centrifugal pump would lift it to any height up to a limit of 20 or 25 ft., and give it an initial pressure after raising it.

Details of Revolving Member

WATER therefore flows up the suction pipe into this revolving pressure chamber or water drum A, Fig. 1, on the periphery of which nozzles B, are arranged not less than ⅜ or ½ in. in diameter on the smaller, and up to ¾ or 1 in. on the larger sizes. These nozzles allow the water to escape form the pressure drum in

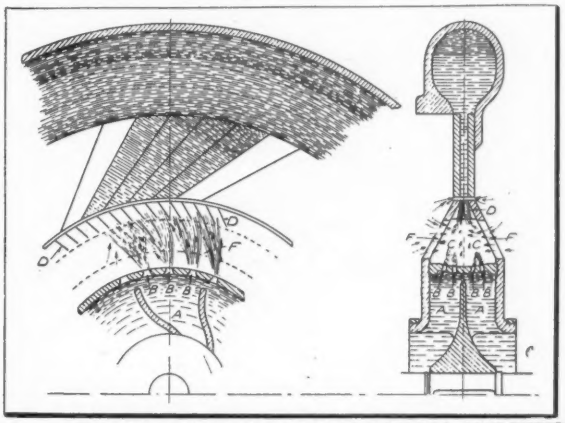


FIG. 1. DIAGRAM OF WORKING OF REES ROTURBO CONDENSER

radiating jets which are arranged to impinge in pairs, by which means, the water jets are made fan shaped and subdivided into a fine spray, and are projected in lines radiating from the shaft (but still rotating as a whole with the impeller) across a space C, into which the steam is allowed to exhaust, through openings F.

As these fan shaped jets are rotating edgewise at a comparatively high speed the area swept by them is very great, although the space occupied by the impeller is comparatively small. This ensures a perfect mixture of steam and water and an ideal condition for the most rapid and perfect condensation.

After the water jets have travelled radially some distance so that the broad parts of the water fans have all combined to form a complete ring of spray and condensed the steam, the problem, as in the case of all other condensers is to extract the condensate and air with certainty and efficiency. The rotating jets of spray or condensate with the entrained air, are picked up by the blades of an exhausting fan D, concentric with the rotating pressure drum and of a much larger diameter, leaving a large steam space between

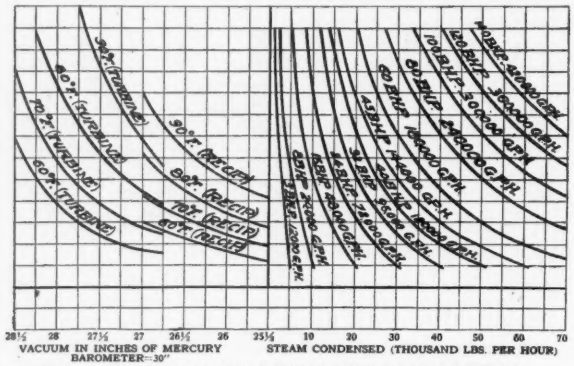


FIG. 3. PERFORMANCE CURVES FOR REES ROTURBO CONDENSER

the water drum and the exhausting fan, the whole forming a single rotary member. By means of the exhausting fan the condensate with the entrained air is ejected with absolute certainty and efficiency.

Automatic Vacuum Regulation

THESE exhausting fan blades also form an automatic regulator, which deals with fluctuating conditions of steam or vacuum without any speed regulation. For instance, when building up the vacuum on starting the condenser, or if the vacuum is reduced below the normal when running, the rim blades are practically empty, and the condensate is swept out through the exhausting fan at full speed. If the vacuum rises beyond normal, thus exerting a greater backward pull, the rim blades fill up with water to a greater depth, and because of the extra centrifugal force created by this greater radial depth and therefore weight of water carried by the fan blades, exercise a greater exhausting effect when running at constant speed.

This regulating effect is due to the water being controlled by the rotary member at both the point of injection to, and ejection from the vacuum chamber, and at the same time allowed to spray freely across a large intervening condensing space. This feature allows of long jets and a great area for condensation as well as the impinging jets which form the finest spray, and enables the apparatus to be used for the largest size condensers, without any auxiliary apparatus for extracting the air or condensate.

Figure 2 shows sectioned views of a condenser for dealing with 30,000 lb. of steam an hour at 28 in. vacuum.

When used as an air pump the same design impeller is used and practically the only difference is that the external casing is of a different shape and has a smaller opening for the entrance of the air than would have been the case had it been for a steam condenser.

Among the advantages of this type of condenser are: Low first cost; small floor space required; simplicity of construction; ability to produce and maintain a vacuum closely approaching the theoretical; stability under varying loads, and capacity to deal with large volumes of air or other vapor; practically automatic starting and operating.

Figure 3 shows the performance curve of standard size Rees RoTURBo condensers with varying volumes of steam, etc. In this curve allowance has been made for 3 cu. ft. of free air a minute per 10,000 lb. of steam condensed an hour for reciprocating engines and half of this amount for steam turbines.

To use these curves with, say 28-in. vacuum, for a steam turbine using 30,000 lb. of steam an hour, then taking the lefthand side and running up the vertical line above 28-in. until the curve marked 60 deg. is reached and passing along this line horizontally to the right until the vertical line from 30,000 lb. of steam is met, a point is arrived at on the curve marked 40 hp. 120,000 g.p.h. This, therefore, gives the horsepower required for this condenser together with the amount of condensing water.

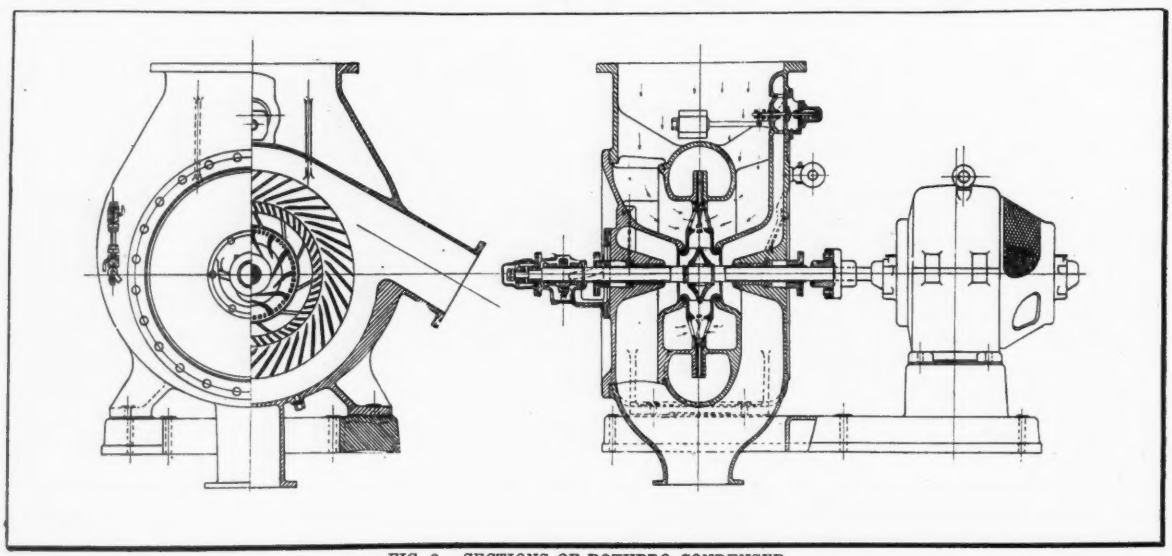


FIG. 2. SECTIONS OF ROTURBO CONDENSER

PRACTICAL MATHEMATICS

Logarithms

WHEN solving many practical mathematical problems, logarithms materially reduce the time and work of the operations, and in fact, many problems can be solved only by their use.

With a little practice the tables of logarithms can be used with rapidity and accuracy. In practice the word logarithm is abbreviated log., which will be used in connection with the following explanations and problems.

If we had an equation, $10^3 = 1000$, the exponent 3 of the power to which the number 10 is raised is the log. of 1000 to the number 10; 10 is called the base of the logarithm and is used as the base of the common logs. In studying powers of numbers we found that, in adding exponents of 2 like numbers, the sum of the exponents was the exponent of the product of the 2 numbers; for example, $5^6 \times 5^4 = 5^{10}$. On the lefthand side of the equation the logs of the 2 factors are 6 and 4, while the log of the product is 10, therefore if we add the logs of 2 numbers, we obtain the log of their product.

In like manner, when dividing, the exponent of the divisor is subtracted from that of the dividend to get that of the quotient; thus: $25^3 \div 25^2 = 25^{3-2} = 25^1$ or 25.

Any number or power of a number may be raised to a higher power by multiplying the exponent of the number or power by the exponent of the higher power. Thus: $(10^1)^3 = 10^{1\times3} = 10^3$; or $(10^3)^2 = 10^{3\times2} = 10^6 = 1{,}000{,}000$.

To extract any root, divide the exponent by the index of the root thus: $\sqrt{4} = 4^{1+2} = 4^{\frac{1}{2}} = 2$; $\sqrt{12^6} = 12^{6+2} = 12^3 = 1728$.

If a table of logarithms to the base of 10 is prepared for numbers, say, from 1 to 9999, not merely for whole numbers, but for all decimal parts as well, we obtain what is called a table of common logs. All numbers lying between 0 and 10 will have a log. lying between 0 and 1, because $10^0 = 1$ and $10^1 = 10$.

Similarly, all numbers lying between 10 and 100 will have a log. lying between 1 and 2, because $10^1 = 10$ and $10^2 = 100$. In the Practical Reference Tables will be found a table of common logs. from 1 to 9999.

Let it be required to find the log. of 29.85. Regard the number simply as a series of figures 2985 and find the first 2 figures in the lefthand column and in the column under the third figure, 8, read 4742. Follow along until under 5 in the supplementary table is found 7, the addition to be made for the fourth figure; $4742 + 7 = 4749$; this is the decimal part or mantissa of the log. and is always positive. The characteristic or whole number is one less than the number of digits to the left of the decimal place of the number of whose log. we are to find, hence the log. of $29.85 = 1.4749$ or log $29.85 = 1.4749$.

If the number for which we want to find the log is less than unity, the characteristic is negative; thus log $0.365 = \overline{1}.5623$, the minus being placed over the characteristic to show that it applies to that portion only and not to the mantissa. Another way of designating a negative characteristic is to add 10 to the index, and to indicate the subtraction of 10 from the resulting logarithm. Thus, log $0.2 = \overline{1}.3010$, which may be written $9.3010 - 10$.

From the foregoing we have seen that for numbers from 1 to 9.99 the characteristic is 0; from 10 to 99.99 is 1; from 100 to 999 is 2; from 0.1 to 099 + is -1; from 0.01 to 0.099 + is -2 etc. Thus,

Logarithm of 2000 is 3.3010; Logarithm of 0.2 is $\overline{1}.3010$.

Logarithm of 200 is 2.3010; Logarithm of 0.02 is $\overline{2}.3010$.

Logarithm of 20 is 1.3010; Logarithm of 0.002 is $\overline{3}.3010$.

Logarithm of 2 is 0.3010; Logarithm of 0.0002 is $\overline{4}.3010$.

Miscellaneous Problems

MISCELLANEOUS problems that follow are to familiarize the reader with logarithmic tables.

Multiplying 120 by 90. In the lefthand column of the tables we find 90 and under the next column headed 0 we find the mantissa of the log which is .9542. The characteristic is one less than the number of digits or 1, hence log $90 = 1.9542$. In a similar manner we find the log of 120 which equals 2.0792.

Log 90 = 1.9542
Log 120 = 2.0792

4.0334 = log of product

of 120×90. In the columns of mantissae find .0334, which is opposite 10 in column 8, hence 10 are the first 2 figures of the required number and 8 the third. As the characteristic is one less than the number of digits, there must be 5 places to the left of the decimal in log 4.0334, hence we add 2 ciphers to 108 to secure the answer, 10800.

Divide 615 by 2.8.

Log of 615 = 2.7889
Log of 2.8 = 0.4472

Antilog 2.3417 = 219.6

By the rules of logarithms we subtracted the log of the divisor from that of the dividend to find the log of the quotient.

Raise 16 to the sixth power.

Log of 16 = 1.2041
6

Antilog 7.2246 = 16,770,000.

In this problem we multiplied the log of 16 by the required power 6 to find the log of that power and by reference to the tables found the corresponding number 1677. As there is one more figure in the answer than indicated by the index of the root, the answer is 16,770,000.

Extract the cube root of 1728. Log 1728 = 3.2375, log of root $= 3.2375 \div 3 = 1.0792$, root = 12.

Here we find the mantissa complete in the third line from the top of table in column 0 opposite 12 in the lefthand column, hence 12 is the cube root of 1728.

Extract the fifth root of 1728.

Log 1728 = 3.2375, log of root $= 3.2375 \div 5 = 0.6475$, root = 4.441.

We find the nearest mantissa that is smaller in the table which is .6474 in the column marked 4, opposite 44; the first 2 figures of the root will therefore be 44, the third figure 4, as that is the column in which the nearest mantissa is found. The difference between this mantissa and the mantissa in the example is 1. We now look in the right column headed 1 and in the same line find 1. The root is then 4441.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

COPENHAGEN WATERWORKS PLANT

Diesel Oil Engine Driving Centrifugal Pumps by Means of Belt

By Frank C. Perkins

At the Thorsbro waterworks of the City of Copenhagen, located at Thorsbro Pr. Taastrup, is an installation of Diesel oil motors driving centrifugal pumps. This pumping station is equipped with well pumps and rotary pressure pumps raising the water form the wells and forcing it into a reservoir through a pipe line 62,336 ft. (19 kilometers) long and 25.7 in. (650 millimeters) in diameter. In this water works there are 6 oil engines in operation 2 of which drive the high-pressure pump and have a capacity of 150 hp. each. Two other engines of 45 hp. ench operate the well pump, while the remaining 2 Diesel engines are used for driving dynamos for light and power service, each unit consisting of an 18 hp. single cylinder oil engine directly coupled to a continuous current electric generator.

The oil is transported to the Taastrup in railway tank cars of a capacity of from 8 to 15 tons, and the fuel oil is hauled to the water works by horse drawn tank wagons holding about 634 gal. (2400 liters). At the water works there are 2 large fuel tanks each having a capacity of 150 tons. The plant has a daily consumption of one ton of oil as a maximum.

The oil is carried by gravity from the storage tank to a fuel tank from which it is conducted to the engine room for use in the Diesel motor, there is a Diesel motor driven compressor utilized together with an electrically operated compressor for supplying an air pressure of 2 atmospheres for forcing the oil from the fuel tank to the engine room, the electric compressor being held in reserve, a pump also being provided as a reserve for forcing the oil to the service tank.

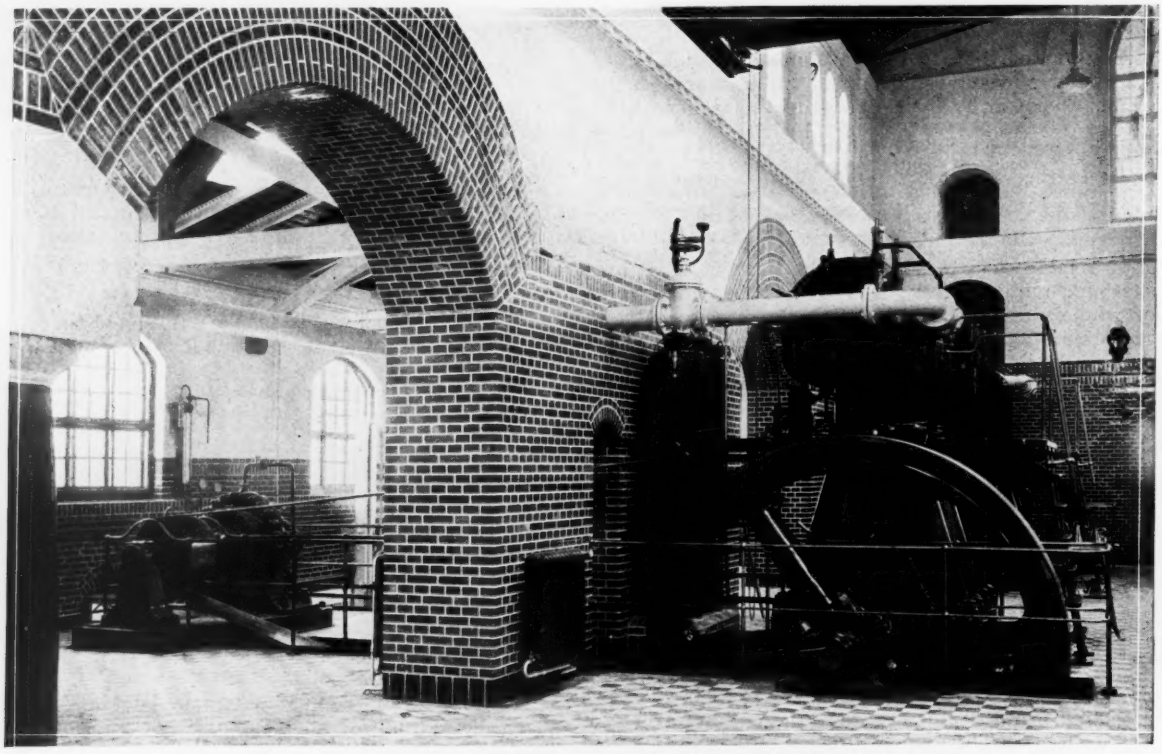


FIG. 3. DIESEL OIL ENGINE AND BELT-DRIVEN HIGH-PRESSURE CENTRIFUGAL PUMP

As noted in the accompanying drawing of this oil driven pumping station there are 2 centrifugal high-pressure pumps operated by 2 cylinder Diesel motors with belt transmission, these oil engines have a stroke of 22.05 in. (560 millimeters) the cylinders measuring

16.3 in. (414 millimeters) in diameter. The engines operate at a speed of 152 r.p m. and the rotary pumps at a speed if 650 r. p. m., delivering from 3170 to 3646 gal. (12 to 13.8 cubic meters) of water under a head of 114.83 ft. (35 meters), these pumps operate with an efficiency of 80 per cent and take from 115 to 117 hp. under normal load. The pump inlet has a diameter of 17.7 in. (450 millimeters), a conical shape pipe connecting with the well pipe measuring 23.6 in. (600 millimeters) in diameter, while the delivery pipe measures 11.8 in. (300 millimeters) in diameter, the rotary of the pump being constructed of bronze and the casing of nickel steel.

The well pumps are driven by single cylinder Diesel motor having a stroke of 18.25 in. (490 millimeters) with cylinders measuring 13.07 in. (332 millimeters) in diameter. These oil motors operate at a speed of 161 r.p.m., driving the pumps by belting at a speed of 770 r.p.m., these pumps deliver 1823 gal. (6.9 cubic meters) of water under a head of 52.41 ft. (16 meters) and have an efficiency of 70 per cent. These mounts require about 35 hp., the delivery pipes of each pump measuring 9.84 in. (250 millimeters) in diameter and the suction pipe 11.8 in. (300 millimeters).

The electric installation at this waterworks includes a storage battery of 120 cells, each having a capacity of 36.5 amperes with 10 hr. discharge or 90 amperes for 3 hr. service. The batteries are charged by the direct current dynamos before mentioned, direct connected to 18 hp. Diesel motors of the single cylinder type. These oil engines operate at a speed of 240 r.p.m. and have a stroke of 13 in. (330 millimeters), the cylinders measuring 8.86 in. (225 millimeters) in diameter.

The current from this storage battery is utilized for driving small electric motor-driven centrifugal pumps for supplying the necessary cooling water to the oil engine. The battery will supply current for operating these motors, for providing the necessary cooling water for 6 hr. without recharging, a reserve electric pump being provided for this service, also an oil motor driven pump being kept in reserve. The high-pressure air compressor is driven by a Diesel motor, an electric-driven unit also being installed.

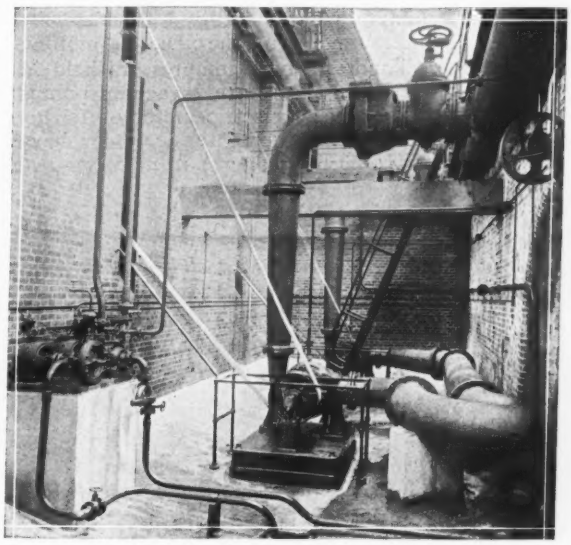


FIG. 4. BELT DRIVEN CENTRIFUGAL WELL PUMPS IN COPENHAGEN PLANT

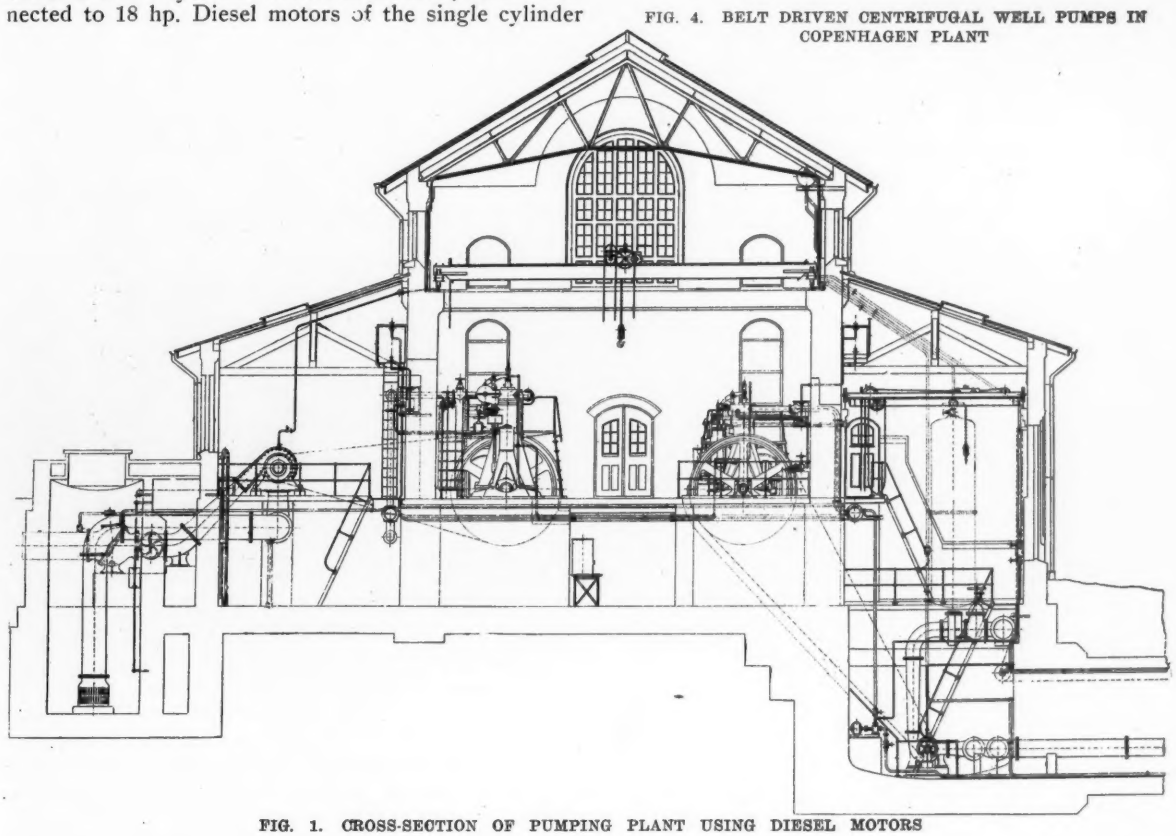


FIG. 1. CROSS-SECTION OF PUMPING PLANT USING DIESEL MOTORS

The diameter of the low-pressure cylinder is 6.3 in. (160 millimeters) and the high-pressure 1.9 in. (48 millimeters) with a stroke of 5.9 in. (150 millimeters). The compressor is driven through gearing by an 8-hp. electric motor at a speed of 185 r.p.m., the air tank can be supplied by the low-pressure cylinder at a pressure of 7 atmospheres. The high-pressure and low-pressure cylinders may be utilized together for supplying high-pressure air to the Diesel motors. There are also oil motor-driven compressors held in reserve for this service. There are 2 vacuum pumps provided, each driven by an electric motor of 1.5 hp. through single reduction gearing, these pumps have cylinders of 5.9 in. (150 millimeters) in diameter and a stroke of 5.9 in.

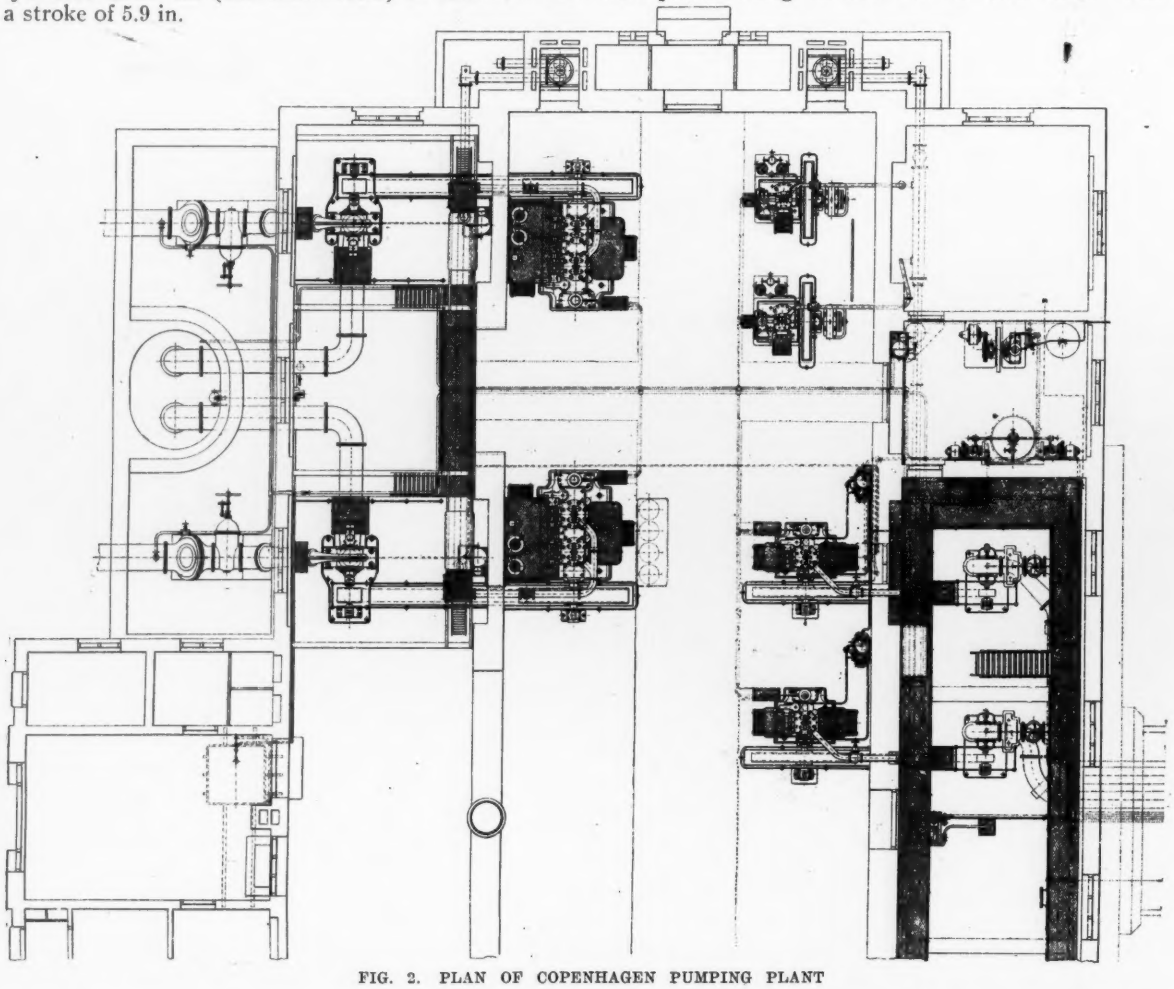


FIG. 2. PLAN OF COPENHAGEN PUMPING PLANT

In this waterworks there are 2 cranes the main engine room being served by a crane of 6.5 tons capacity and the well pump room by a 2-ton crane.

It is of interest to note that the oil engines driving the high-pressure pumps under test operating at a speed of 150.5 r.p.m. with an indicated horsepower of 181.5 and an effective load of 151.5 hp. delivering 255,376 gal. (966.6 cubic meters) of water per hour, showed a fuel consumption of 2.75 lb. (1.25 kilograms) of oil per hour. The compressor oil consumption during this test was 0.368 lb. (0.167 kilograms) per hour and the efficiency of the pump was 77.3 per cent. During the test the total oil consumption was 61.9 lb. (28.08 kilograms) per hour and the oil consumption per horsepower-hour was from 0.34 to 0.54 lb. (154.5 to 247 grams). The horsepower used by the air pump was 15.8 and the air pressure 857.7 lb. per sq. in. (60.3 kilograms per square centimeter).

It is of interest to note that the temperature of the cooling water entering the machine was 46.4 deg. F. (8 deg. C.) and on leaving the motor the temperature of the water was 96.8 deg. F. (36 deg. C.). These pumps were operating at the time under a head of 146 ft. (44.51 meters).

The oil engines driving the well pumps during 2 tests showed an efficiency of 66.5 per cent and 70 per cent. The oil motors showed an effective output of 35.4 hp. and 34.3 hp. respectively, the indicated horsepower being 48 and 47.7 in each case. There were 98,018.2 gal. (371 cubic meters) and 101,088.2 gal. (382.62 cubic meters) of water delivered per hour in each of these tests under a head of 53.5 ft. (16.3 meters) and 52.3 ft. (15.93 meters), the speed of the Diesel motors was 165 and 162.6 r.p.m. respectively and of the pumps 846 and 841.5 r.p.m. The temperature of the cooling water was 46.4 deg. F. (8 deg. C.) entering the engines and on leaving the engines the temperatures were 104 deg. F. (40 deg. C.) and 114.6 deg. F. (45.9 deg. C.) respectively. The total fuel consumption per hour was 17.08 lb. (7.75 kilograms) and 15.98 lb. (7.25 kilograms) of oil, while the consumption per horsepower-hour was 0.357 lb. (162 grams) and 0.335 lb. (152 grams) respectively.

HORIZONTAL DIESEL ENGINE OF AMERICAN MANUFACTURE

New Design of Otto Gas Engine Works for Using Crude Oil and Residuum

DEVELOPMENT of the internal combustion engine to operate successfully and with the greatest possible enconomy not only on crude oil, but also on the residual byproducts of gas and coke manufacturing plants, is bound to attract the attention of every one interested in the production of power at the lowest possible cost.

An engine of this type is represented by the horizontal Otto Crude Oil Engine operating on the Diesel method of fuel injection and combustion, as shown in the illustration. It is the first horizontal type built in the United States. The advantages which explain the phenomenal success of this type of engine are due to an entirely new principle of handling liquid fuels of low degree, such fuels as have not heretofore been converted into power without the use of expensive and complicated auxiliary apparatus for the purpose of vaporization. The Otto Crude Oil Engine uses these fuels in their simplest, safest, least expensive and most generally available form. Crude oils and residual oils obtained in refining mineral oils of all kinds are available at prices ranging from 2½ to 4 cents a gallon, according to the distance from the oil fields to the destination of shipments. Considering that the Otto Crude Oil Engine is stated to develop a brake horsepower hour on 1-15 gal. of these fuels, it will be seen that the fuel cost per brake horsepower per hour would be from 1-6 to 1-4 of a cent.

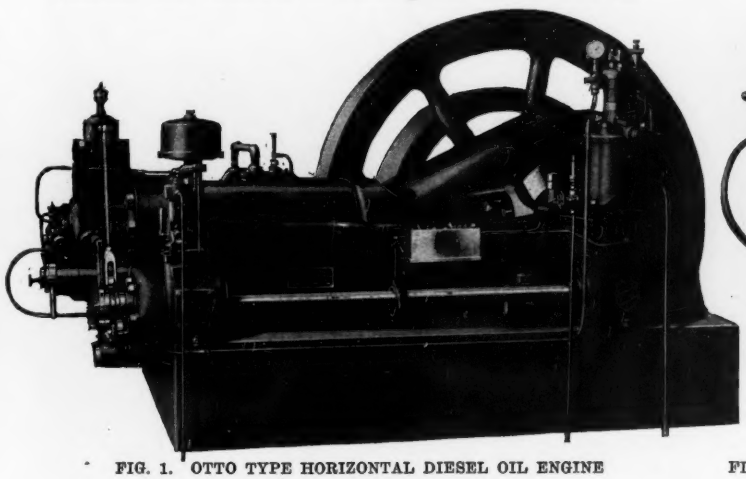


FIG. 1. OTTO TYPE HORIZONTAL DIESEL OIL ENGINE

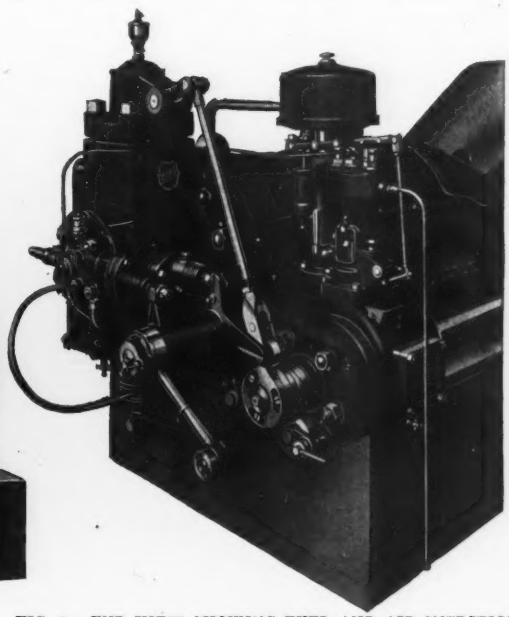


FIG. 2. END VIEW SHOWING FUEL AND AIR INJECTION CONTROL

This engine is of the single acting type. A charge of pure air being admitted into the cylinder through the inlet-valve, compressed during the succeeding stroke until its temperature exceeds the temperature at which the fuel ignites, the latter being injected into the heated air at the end of the compression stroke and ignited spontaneously by the highly heated air in the cylinder and burning steadily for a part of the expansion stroke. The quantity of fuel injected into the cylinder by the oil pump is automatically regulated by the governor to conform to the load carried by the engine at any time, which is done by varying the closing of the bypass valve in the overflow chamber.

The engine is started by means of compressed air at low pressure, supplied from a reservoir which is filled from the air compressor on the engine, admission of the air into the cylinder being controlled by the mechanically operated starting valve. A low-pressure safety valve, set at 220 lb., is placed on the compressor, and high-pressure safety valve, set at 1200 lb., is provided on the fuel injection valve. Also a safety valve, set at 220 lb., is used on the compressed-air reservoir.

When using fuel oils of average heating value (about 18,000 B. t. u. per lb.) the consumption of the Otto Crude Oil Engine will be as follows: At full load, 0.50 lb. brake hp. hour; at ¾ load, 0.56 lb. per brake hp. per hour; at ½ load, 0.62 lb. per brake hp. per hour; at ¼ load, 0.74 lb. per brake hp. per hour.

Variation in the speed of the engine between full load and idle running does not exceed 6 to 8 r.p.m. or less than 4 per cent. On special electric engines the size and weight of the flywheel is proportioned so as to keep the cyclical variation in speed within limits which will result in regularity being obtained within 3 per cent each way, from mean rated speed with gradual change of load.

The Otto Crude Oil Engine has been in use abroad for some 12 yr. on all sorts of low-grade oils. Perhaps the severest test thus far has been a long run on a heavy oil containing 6 per cent asphaltum. This oil is so thick that a larger pipe had to be used to convey the fuel from the tank to the fuel pump. The engine developed the same horsepower with this oil as with lighter oils, and showed almost complete combustion.

The Otto Gas Engine Works of Philadelphia will build and market the engine in this country.

A SIMPLE RULE for ascertaining transmitting power of belting without first computing speed per minute that it travels, is as follows: Multiply diameter of pulley in inches by its number of revolutions per minute, and this product by width of the belt in inches; divide this product by 3300 for single belting, or by 2100 for double belting, and the quotient will be the amount of horsepower that can be safely transmitted.

WITH THE POWER BUILDERS

Comparing Cost of Gas and Steam for Small Powers. To Figure Gas Engine Rated Power. A Successful Gas Turbine

AFTER the usual welcome and response, and a report by Treasurer Knoblock, showing a substantial balance on hand, President Parker gave some results of his investigations as to the attitude of members on changes of policy of the Association and outlined the subjects to come up for discussion and action. These included the establishment of a formula for figuring horsepower rating from bore, stroke and speed, changing the dues to raise funds for the employment of a paid secretary, the holding of a gas engine show in 1913, pushing of the Rainey Bill for establishing a Bureau of Farm Power in the Department of Agriculture.

Many opinions of many minds were expressed in the discussions and much work was put into the hands of committees for further consideration.

The question of a show was left to a committee consisting of O. C. Parker, chairman; John Lauson, Chas. White, O. M. Knoblock and H. W. Bolens, to decide on place and date and make full arrangements. Kansas City, Toledo, Chicago and Milwaukee were mentioned as possible locations.

Horsepower Rating

AS to a rule of thumb formula for engine rating, it soon became evident that it was not possible to set any standard which would apply to all classes and conditions of engines and the whole matter was referred to a Horsepower Standardization committee to be appointed by the Executive committee and which should consider the subject and report at the next meeting. The only concrete suggestion was that for gasoline engines up to 15 hp., the rating be figured as: Bore Squared times Stroke times R.P.M. divided by 16,000 for 4-cycle engines, and by 12,000 for 2-cycle. For illuminating gas and steam the divisor 15,000 was given as being accurate within 5 per cent by H. W. Jones, who also said the no-load gas consumption for most engines was 20 per cent that at rated load.

Prof. Rose stated that the constant was found to vary for farm engines from 11,100 to 21,800 for engines from 20 to 60 hp. at 550 to 700 ft. piston speed; that it varied according to load, speed, number of cylinders and fuel, hence any fixed value was impossible.

Brake test for delivered horsepower seemed the only agreed fair standard and one designer gave this as 1.85 hp. for a 4 by 4-in. engine at 500 r.p.m., rated at 1.5 hp., 20 hp. for a 12 by 12-in. at 200 r.p.m., 25 hp. for 12 by 12 at 250 r.p.m., and 27.5 hp. for 12 by 12 at 300 r.p.m, as the valves did not seem to act rapidly enough at the last speed to let the engine hold up to proportional power.

Insurance with Gasoline

REPORT of the insurance committee showed that suction feed as well as pump feed gasoline engines will be approved by the Underwriters Laboratories, if they meet certain requirements as to fire safety, that only one inspection is required for an entire line if all are of like construction and grade, that modifications from portable to stationary can be made by supplementary partial inspection and changes in minor details of construction can be approved from blue prints without charge. Also that approved engines can have a label attached to each engine at small cost, which guarantees the user against additional premium where such engines are used.

For engines carrying their own fuel tank, the tank must be a permanent part of the structure fixed to the base, not to skids, must have walls at least 3/8 in. thick if of cast-iron or No. 18 gage if galvanized in small sizes and thicker for large sizes, and must not hold over 10 hr. supply. Flange connections to the tank must be substantial, and held by at least 3 rivets.

Where a separate tank is used, both tank and engine must bear the Underwriters' label to be approved as a risk without extra premium.

The Money Question

RAISING the dues is always a question arousing lively interest. It was fairly well agreed that too much work was being put on unpaid officers, and that some way should be devised of relieving them, but how far the Association could safely go was vigorously debated, some advising raising all dues to $25, others dividing into active and associate members with different dues and privileges.

In the final vote it was decided to raise the dues of all members to $10 a year, making no change in classification.

New Officers

ELECTION of members of the executive committee resulted in the choice of O. M. Knoblock, S. M. Walker, R. A. Oglesby, and the committee chose as officers: O. C. Parker, re-elected president; R. A. Oglesby, vice president; O. M. Knoblock, re-elected treasurer, and H. R. Brate as paid secretary, the new position provided for by the raise in dues.

Decision was made to hold one meeting a year hereafter, the Gas Engine Show to take the place of the summer meeting, and the annual meeting to be held in December.

As a result of discussion on the subject of Cost Accounting brought out by a paper by C. B. Seguer, the subject was made a special order of business for the next annual meeting to be taken up by papers and committee reports.

The paper by Mr. Wagner is given at length in this issue.

Gas Engines in Industries

WAS the subject of a paper by Charles Kratsch and was discussed by H. W. Jones, the figures given arousing great interest, but being so definite as not to provoke discussion.

Mr. Kratsch said in part:

At Racine 2 yr. ago you listened to a table of percentages on what constituted trouble calls and their causes. In the last 3 mo. I have again listed a number of such calls and tabulated them along nearly the same lines as in my previous article.

Causes due to—	1910	1912
Installation, per cent	7	2
Fuel, per cent	13	12
Instruction, per cent	10	5
Faulty design, per cent	5	2
Natural wear, accident and ignition, per cent	36	68
Equipment and accessories, per cent	29	11

This difference is due to the fact that we have been practicing what we preach. In the last 2 yr. we have

been instructing our customers in the proper care and operation of their power plants, and installing on the various engines all of the most modern accessories that go to improve the gas engine's efficiency. It would be an injustice for us to fail to accord to the built-in magneto the credit justly due.

In the year 1901 our firm installed a single cylinder, 30-hp., horizontal engine, which was second-hand at that time, and we presume had seen about 10 yr. of service before we got it. It is in charge of a man about the place who spends about 90 per cent of his time at other work. It is pulling full load to no load from 10 to 14 hr. a day. Ignition is by wet battery, requiring renewal about twice a year. Our firm has done all the work on this engine since installation, which included recharging of the batteries, igniter points, all repairs on parts worn, and in fact everything that was needed to keep the engine running.

On the following table the cost of battery renewal is separated from the balance of the work to show this item of expense, as we claim in the past few years it could have been considerably reduced had the owner allowed us to put in, first, the friction or belt-driven magneto, and later the built-in type. These charges include everything from starting the engine when the engineer was stuck, to reboring the cylinder when needed. Cost of maintenance was as follows:

Year	Battery	Repairs	Gas Bill
1902	$21.10	$82.10	
1903	23.40	36.89	
1904	20.50	62.10	
1905	26.90	33.41	
1906	18.60	38.30	
1907	21.00	27.10	
1908	21.00	104.90	
1909	25.40	10.75	
1910	19.60	4.27	$486.20
1911	21.40	41.58	435.20
	218.90	484.40	
		218.90	
		$703.30	

For 4 engines installed at about the same time, but figures for which are available only since 1907:

Year	Single-cylinder 60-hp. Full load continuous, sometimes 24 hr. a day.	Single-cylinder 18-hp. Full load.	Two-cylinder 15-hp. Full load.	Single-cylinder 12-hp. ¾ load.
1907	$ 42.50	$ 24.20	$15.20	$52.15
1908	62.10	25.92	19.70	32.76
1909	59.40	28.60	14.80	10.70
1910	60.60	96.60	17.55	19.90
1911	123.20	16.12	7.10	10.80
	347.80	191.44	74.35	126.31

Battery and ignition apparatus is included, but possibly some sets of dry cells might have been purchased by the engineers in urgent cases.

When you consider that these charges cover accidents, renewals of worn out parts, and cost of expert's time at 70 cents an hour from time of leaving shop to return, and distances in Chicago these showings are not bad, and cover, in the 12, 60 and 18-hp. sizes, reboring of the engine cylinder.

Also remember these amounts cover the installation of the various new and approved appliances that we have placed on these engines, and that today they are practically up-to-date. This showing, while actual cost, is extremely low in percentage of repairs alone. So far as maintenance is concerned, the cost of the first 5 yr. service, either new or rebuilt, is practically nil; the trouble calls are generally educational to the operator and should not be classed as maintenance. Strange as it may seem, it has been our experience that the increase in the use of gas power shows a decrease in the average cost of repairs, which we think is due to the better grade of operators.

For the past 15 yr. we have sold, installed, operated, and maintained nearly every make of engine under almost every possible condition, considering the smaller sizes up to 200 hp., and have been forced to compete with both the low and high grade steam engine, with installations of electric motors on central station and suburban electric line service, with charges from 2 to 10 cents per kw.-hr.

As a matter of comparison let us take a plant of 20 hp. average load during a day's run, with a peak load of possibly 30 hp. Figures are based on gasoline at 14 cents a gallon, electric power at 3 cents a kw.-hr., coal at $3.50 a ton delivered in the firebox, and city gas at 80 cents for 1000 cu. ft.

Steam Power Cost

TAKING the ordinary small steam plant with a 50-hp. boiler and delivering an average of 20 hp., the cost will show up about like this:

Twenty-horsepower average load running from 5 to 30 hp. for 9 hr. a day, off and on, during a month's run, will require a 50-hp. boiler, and when this plant is pulling the 5-hp. load it must be prepared instantly to deliver anything up to 30 hp.

The average small plant is seldom, if ever, equipped with economical devices—water heater, separators, etc.—and taking 20 hp., 9 hr. a day, 26 days a month, with the standby losses, a consumption of coal of 10 lb. a hp.-hr. is conservative. This equals 4680 hp.-hr., which at 10 lb. of coal gives a consumption of 46,800 lb. or 23 tons, which at $3.50 a ton delivered in the firebox, costs $80.50.

For both gas and steam the consumption of water is about the same, approximately 4 gal. a brake hp.-hr.

Gasoline Cost

WITH a gasoline engine of 30 hp., with gasoline at 14 cents a gal. (which is very low, as gasoline will cost in any quantity considerably more as the market is today) the results appear thus:

Taking 4680 hp.-hr., as before, and a gasoline consumption of one pint per hp.-hr. or 585 gal., which will cost $81.90; or with a varying load, approximately $80.

Electric Power Cost

IN the gas and steam plant we delivered to the belt 4680 hp.-hr. In order to do this with electricity we must allow for an efficiency of 85 per cent, which is a very conservative estimate at this load. $4680 \times 746 = 3{,}491{,}280$ watt-hr., or 3491.3 kw.-hr., or at 85 per cent efficiency, 4107.4 kw.-hr. supplied, which at 3 cents a kw.-hr. would be $123.32.

Cost with Manufactured Gas

CITY gas in Chicago costs 80 cents a 1000 cu. ft., with a heat value of about 650 B.t.u.

A modern gas engine of today will develop 1 hp.-hr. on 18 cu. ft. of gas, pulling normal load, and 30-hp. gas engine can furnish variable power for a total as required for a month for approximately $70.

With an engine using 18 cu. ft. of gas per hp.-hr., pulling normal load, there is a friction loss of 20 per cent on the hit and miss type of governor. Twenty

per cent of its full load consumption is required to pull the engine light. Taking this into consideration, each additional horsepower that you add will take approximately 15 cu. ft., and requires no more gas for the first horsepower, after the engine is up to speed, than it does for the last. Taking a 30-hp. engine, the gas cost for a month's run of 234 hr. a month will appear thus, with gas at 80 cents a thousand, and using for friction of engine only, about 1 4/5 cu. ft. a min.

Gas Cost for 30-hp. Engine, 234 hr. a Month at Loads as Shown

B.H.P.	Cu. Ft. a minute	Cu. Ft. an hour	Cost for the month
0	1 4/5	108	$20.22
5	3	180	33.69
7	3½	210	37.31
9	4	240	44.92
11	4½	270	50.54
13	5	300	56.16
15	5½	330	61.78
17	6	360	67.40
19	6½	390	73.02
21	7	420	78.64
23	7½	450	84.26
26	8	480	89.85
28	8½	510	95.47
30	9	540	101.08

To Figure the Gas Bill for a Uniform Load

TO determine what the approximate gas bill will be for the month, take the reading in feet per minute and if the cost of gas is:

60 cents per M. multiply the ft. per min. by $8.
70 cents per M. multiply the ft. per min. by $10.
80 cents per M. multiply the ft. per min. by $11.
100 cents per M. multiply the ft. per min. by $14.

In proof of the constant, Mr. Jones showed that 5 cu. ft. of gas a min., or 300 cu. ft. an hr. for 234 hr. would be 70,200 cu. ft.

For 60 cents per M.; 5 × $ 8+ = $40+
For 80 cents per M.; 5 × $11+ = $55+
For $1.00 per M.; 5 × $14 = $70

70.2 M × .60 = $42.12
70.2 M × .80 = 56.16
70.2 M × 1.00 = 70.20

Applying the costs as worked out by Mr. Kratsch, and assuming the same fuel costs and 20 cu. ft. of gas per hp.-hr., Mr. Jones gave the following table of comparative costs per year:

Yearly Cost for 30-hp. Installed Delivering 20 hp. Average 234 hr. a Month

	Electric Motor	Steam Engine	Gas Engine City Gas
First Cost.....	$500	$1200	$1100
Depreciation 5%	25	60	55
Maintenance 5%	25	60	55
Installation 6%	30	72	66
Water	0	25	25
Oil	10	25	48
Fuel	1478.64	966	898.56
Attendance	25.	400	180.
Total	1593.64	1608.00	1327.56
	1327.56	1327.56	
Yearly saving by Gas Engine.....	266.08	280.44	

Averaging this at $275 saving a year would pay for the gas plant in 4 years, thus writing off its cost and leaving the worth of the electric and steam installations less depreciation, as $500 — $100 = $400, and $1200 — $240 = $960 respectively. For the other 6 yr. of a 10-yr. period, the costs would be as follows:

	Electric Motor	Steam Engine	Gas Engine
Cost at Start.....	$400	$960	0
Deprec. 5% for 6 yr.	120	288	0
Mainten. ....for 6 yr.	150	360	330
Int. .....6% for 6 yr.	144	345.60	0
Water .....for 6 yr.	0	150	150
Oil .....for 6 yr.	60	150	288
Fuel .....for 6 yr.	8871.84	5796	5391.36
Attendance, for 6 yr.	150	2400	1080
Total	$9495.84	$9489.60	$7239.36
	7239.36	7239.36	
Net 10 yr. advantage of Gas Engine....	$2256.48	$2250.24	

And in addition the gas engine plant is still on hand and worth, on the same 5 per cent basis of depreciation as for the others, $550. So that the total gain would be $2806.48 over the electric motor power and $2800.24 over steam.

THE GAS TURBINE PROBLEM*

Details of Operation and Results Secured from Constant Pressure and Explosion Types and Comparison with Gas Engine Performance

By F. C. Wagner

IN the gas engine heat may be added to the working fluid either at constant volume, as in the explosion of the common 4-stroke cycle, or at constant pressure as in the Diesel type. Likewise the gas turbine may work on either principle and both have been attempted.

At Constant Pressure

IN 1906, Rene Armengaud built 2 turbines of 30 and 300 brake hp. of the constant pressure type. The smaller was somewhat like a De Laval steam turbine, supplied with air from a high-speed air compressor and with gasoline blown through an atomizing nozzle into the combustion chamber, where the mixture was ignited by an incandescent platinum wire. Burning of the gasoline increased the volume of the air at constant pressure substantially as in the Diesel engine, and the hot gases were expanded through a nozzle into a high velocity jet which acted on the turbine wheel.

To protect the metal from high temperature, the nozzle was water jacketed and the combustion chamber lined with carborundum. Also, to save the wheel, a jet of steam was forced into the mixture just before it entered the nozzle, thus lowering the temperature of the gases.

At 145 lb. per sq. in. the temperature in the combustion chamber was 3200 deg. F., in the exhaust, 740 deg., and the turbine was reasonably durable and could operate continuously. The power from the turbine was about twice that needed to drive the compressor.

*Read before the National Gas Engine Association at Indianapolis.

Lowering the temperature of the gases before expansion reduced the efficiency, and to improve this and avoid a separate boiler to furnish the steam jet, the larger turbine had a coil of pipe, to form a flash boiler, placed in the exhaust gases from the turbine. Water from the nozzle jacket passes to this coil, is made into steam and used for the jet to mix with the gases just before entering the nozzle. Mr. Armengaud suggested that if the steam were expanded through a separate nozzle, the gases would not be cooled before expansion, so that the efficiency would be improved, yet the wheel would be kept at proper temperature by the steam jet acting alternately with the gas jet.

To furnish the compressed air, a 4-stage inverted turbine compressor was combined with the turbine, giving 112 lb. per sq. in. and also pumps for water and gasoline were built into the unit.

Even at that the fuel consumption was 3.9 lb. per brake horsepower, about 6 times that for a good reciprocating engine.

Constant Volume Type

IN the turbine corresponding to the explosion engine, Hans Holzwarth describes in a recent book the construction and testing of a machine designed for 1000 hp. This has 2 rows of moving and 1 row of stationary blades, the wheel being horizontal, as in the Curtis vertical steam turbines. Ten explosion chambers are arranged on the casing, each delivering an intermittent jet through its own nozzle upon the wheel. Valves close the nozzles while taking in and igniting a charge. These valves lift automatically under excess of pressure in the explosion chamber, but are held open mechanically for a definite time after explosion. Separate valves, which admit air and gas, are operated by oil relays at the proper times.

Air enters at 15 lb. per sq. in., then gas sufficient to form an explosive mixture, which a jump spark ignites. The explosion lifts the nozzle valve, letting the gases expand onto the wheel, and the valve is held open while the pressure drops and the air valve is opened, permitting a gust of air to blow through the chamber and nozzle upon the wheel, scavenging the chamber and cooling chamber and wheel sufficiently to protect the metal. The nozzle valve then closes, gas is admitted and the operation repeated.

Waste heat from the exhaust is used to generate enough steam to operate air and gas compressors.

Producer gas of about 130 B.t.u. per cu. ft. was used as fuel, and it was found that with 10 explosion chambers acting, much less power per chamber was developed than when 4 or 5 were acting, the explosions apparently interfering with one another. With 4 acting, 121.6 brake hp. was obtained, at 8 per cent thermal efficiency.

In more recent experiments, with nozzles of constant cross sectional area, 450 hp. was developed at 20 per cent efficiency, which compares well with the 24.15 per cent obtained in the large gas engines at the Duquesne steel work as given by A. N. Diehl.

The turbine was working at only 15 lb. compression as compared to the 70 lb. common in engines.

Discussion seems to show that this turbine is coming near to the efficiency indicated by theory as being possible, and that the best field of the gas turbine will be in large units to handle large volumes of gas in a small machine and where it will be worth while to install apparatus for saving heat from the exhaust gases.

KNOWLEDGE IN CAPSULE FORM

By the Journeyman Engineer

WHAT a simple process! Say to yourself, "I need to know more about this or that engineering fact, I will go to the knowledge 'Doctor,' he will fix me up." The "Doctor" would give you as a patient the prescribed dose for the kind of information wanted. All done, no worry, work or fuss —'twould be very simple, would it not?

Yet hundreds of men seem to have that idea when a problem comes up for answer. A certain plant in Kansas finds it necessary to change from natural gas to steam. The power plant men in charge are proficient in simple gas management, but are not up to handling a steam plant. The change is entirely unexpected and the men have fears of losing out.

Knowing something of their plight before seeing them, the following remarks are about what I expected:

No, they hadn't any one of them been subscribing to Practical Engineer or any other magazine. One of the men had a few books which he said he had referred to occasionally, but said he found improvements in present-day practice untouched by the books in his possession.

Up-to-date men realize the tremendous value of a library of engineering and technical books, but if these men employed in the Kansas plant had also surrounded themselves with current issues of best magazines like "Practical Engineer" they would in all probability have been prepared for the sudden change in the operation of their plant.

Many power plant men buy books and magazines from a sense of pride. They like to look at their bookcase full of nicely bound volumes. They find pleasure in pointing to the pile of magazines on their desks in their engine rooms. A surrounding of books and magazines gives them a feeling of wide knowledge.

That's a commendable feeling, but a better one is the wholesome possession of every bit of information that these books and magazines contain so as to use it.

It is only the old or the wealthy that purchase technical reading matter for amusement. Active, on-the-job engineers spend money for magazines and books for what they will get out of them. And they make Time give them a chance to read.

A few months ago I was invited to stay over and have supper with an engineer long in my acquaintance. This engineer also had a son following the same calling. The conversation before supper turned to reading, etc. The son remarked, "I never seem to have the necessary time to spend in reading." His father answered: "What are you doing this minute?" "Why! Waiting for the supper bell." "Well," said the father, "you know supper is always at 7 o'clock, here it is 20 minutes to 7—you'll have 20 minutes to read right now if you wish."

The busy engineer sometimes has to force Time to give him a chance at his books and magazines, but 20 minutes a day, 7300 minutes a year, will place him in a safe position where he will never frantically wish for a prescribed dose of information that is needed unexpectedly as did the Kansas men.

Almost any article in Practical Engineer can be read through the first time in 20 minutes—it may take another 20 minutes to fix all points in mind, but the first reading will point out the particular features to be studied.

LETTERS DIRECT FROM THE PLANT

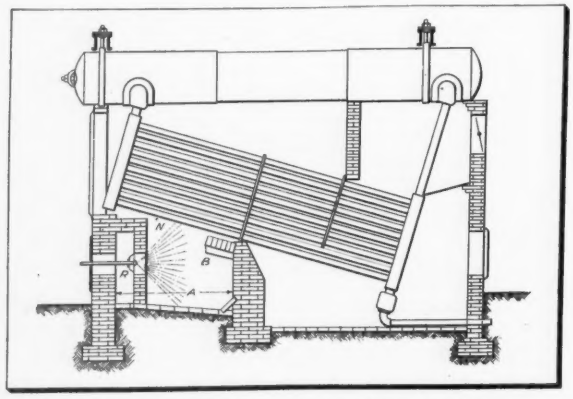
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

A LESSON IN CONSTRUCTING AN OIL-BURNING FURNACE

SEVERAL months ago I had charge of an electric plant located in the western highlands of the U. S. A. Coal had been our fuel right along, but a little theoretical consideration showed us where we might make a large saving by the use of oil for fuel. After a deal of deliberation and investigation it was decided to equip the boiler furnaces with the necessary apparatus for burning oil. A mechanical system of atomization was selected and we installed it ourselves according to plans made by ourselves and the builders of the apparatus.

Our boilers were of the B. & W. standard stationary type and the oil-burning devices were of the front feed variety.

During the installation of the apparatus, we were obliged to work our boilers in such a way that some



OIL BURNING FURNACE WHICH PROVED A FAILURE

of them got heavily overloaded at times. After letting down the first boiler equipped, to see what effect the oil fire was having, we found a burned spot on one of the tubes back toward the bridge wall. We thought from this that maybe it would be better for the tubes all around if a protecting arch of fire brick were built over the furnace at the back end, so as to give a sort of reverberating character to the flames and absorb any blow-pipe effect that might tend to develop in the oil jet.

Accordingly, I took the matter up with headquarters and got the necessary firebrick. We built the arch. The illustration shows where and how it was arranged; it extended 2 ft. forward from the bridge wall, the furnace depth A, being 7 ft.

After we got the first arch built, we started a fire under that boiler and went right along equipping each boiler, as we could take it out of service, with the protecting (?) arch.

About 4 weeks elapsed before we got the first boiler out of service again. As soon as it was cool enough, I crawled into the furnace to have a look at our arch and the tubes. One look sufficed to make my heart beat in quicker time. Six blisters, one of them bad, I counted in my dismay, upon that bunch of erstwhile fair, smooth tubes. I didn't wait to get out of the furnace, but knocked that arch down then and there. Instead of being a protection, as I had fondly hoped for, it had proven an utter foe.

After I got out of the furnace we procured a long bar, and without waiting for the fires to go out, went at the other furnaces and knocked the arches down. As fast as we could, we took these boilers out of service and found the same conditions applying to all—tube after tube burned and blistered where all had been serene and flawless before those unlucky arches had been built.

The burners were of the type and arrangement shown in the figure, giving a whirling spray effect in front of the cone R. The oil was forced through the burner at a pressure of 100 to 150 lb. per square inch, after having been heated in a steam heater to about 200 deg. F. Apparently it had not been thrown toward the back end of the furnace with anything like the force we had imagined; and after the arch was put in, the change it produced in the draft carried the flames with a blow-pipe effect directly up against the tubes—the very thing we wished to avoid. The burns occurred almost in a line across the boiler, about 2 ft. from the front end of the furnace, as indicated at N. Had it not been for this peculiarity in the location, we would have held oil in the feed water responsible for the damage, as most of our exhaust was condensed and returned in the feed water. Also, we reflected, there had been no blistering of tubes in the old coal burning days, although the feed water was quite as oily then as now.

It might have been that, with a steam atomized oil flame, or any other type of burner where the flames are carried forward from the burner with greater force than in our case, the arch would have proven to be the right thing. It was a good lesson in oil-burning furnace construction, though inclined to be somewhat expensive.

Anon.

HEATING OF CRANKPIN

ON page 947 of your September 15 issue, L. A. D. mentioned the fact that a certain crank pin on a 50-ton ice machine would run hot at irregular intervals, and to meet such emergencies he always keeps a separate oil can containing lubricating oil and graphite.

If he will use a moderate quantity of pure graphite in the regular lubricating oil or grease, these unexpected emergencies will not occur. It is essential that a very pure graphite, such for instance, as the electric furnace variety, should be used in order that there may be no mineral matter to accumulate in the bearing.

Note that the difficulty of handling graphite in oil has been entirely overcome by the liquid graphite that is being marketed, this being made from the Niagara Falls electric furnace graphite, and it is possible to use the material continuously as insurance against hot, troublesome bearings.

The liquid graphite may be used without mixture with oil for cooling down a hot bearing, and then after the bearing is cooled, the addition of the liquid graphite to the oil as directed by its manufacturers, will keep the bearings at a satisfactory temperature.

W. H. Sipe.

TROUBLE WITH POUNDING ENGINE

THE engine was a large, heavy duty type, trunk bed machine, semi-automatic valve gear (a modification of the Meyer gear, similar to a Buckeye) consisting of a pair of disks sliding within ported sleeves or bushings pressed into the main valve, the main valve and cutoff valves having separate eccentrics. It was doing about 300 or 350 hp. at 120 to 125 r.p.m. under 115 lb. of steam and bucking a back pressure of from 4 to 18 lb. gage.

I was night electrician in the mill, and passing through the engine room, I noticed No. — had a dull, heavy thud accompanied by a clicking sound, as the crank passed centers. Not being connected with the steam end, I paid no particular attention to it. Later, about midnight, going through again, I noticed the sound was more heavy and the clicking more pronounced. The engineer on watch knowing me to be an engineer, hailed me, "Say, what do you make out ails No. —? I can't locate that slack or clicking." A home-made sheet iron oil guard over the crank acted as a sort of sounding board, so that the sound had lost many of its characteristic "ear-marks," so little could be judged from it. Standing near the guides, it seemed that the crosshead brasses were loose or that the crosshead block lifted as it passed centers, but there was not the jar at the guides as there would be in that case.

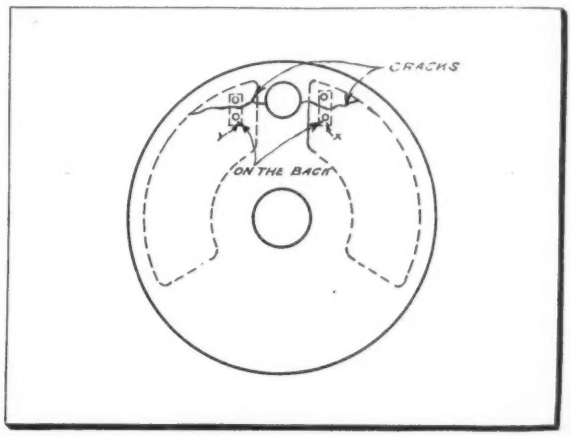
Again standing near the main bearing, the racket seemed to be from the cutoff valve eccentric (which is set about 180 deg. ahead of the crank), and a very heavy jar was noticeable to the hand upon the main journal cap, yet that clicking in the cylinder, as though a ring were stuck or that it was "over reaching" into the counter-bore. The shaft was rolling true with but little end play and no unreasonable slack in either bearing—where was that lost motion?

The oil guard kept you from catching the crank, and a flood of oil (gravity system) smothered the sound. Yet the sound coming mostly from under that guard lead me to ask the engineer "What have you thought about a loose crank pin?" He answered, "No, that pin hasn't been in 2 months yet; that can't be loose." I told him I'd suspect it less if it had run 2 yr. rather than 2 months. Not being able to convince him, I left for the generator room. Returning again about 5:30 a.m., I found a noisy engine—the sound a bit heavier and the clicking more pronounced.

At 6 a.m., he was ordered to shut down, and as I had hung around, I stood near the main bearing and listened. The back-pressure gage showed 16 lb. and as soon as he shut it off, the clicking ceased and the jar became hardly noticeable. I was convinced it was a loose pin. The pin was a pressed fit into the web of the disk and held at the back by a thin jam nut. I had my motors to attend, so I left, returning again about 6:45. The jam nut was loose and the pin eye was cracked either way through the web out to the rim of the disk, and the pin had turned about ⅓ of a turn around in the eye. What held that engine together?

But his (not the chief engineer) way of repairing! Well, it was unique.

Leaving the pin in and tightening up on the jam nut was the start of the job. Then a hoop of 2½ by ⅞-in. iron was welded together (allowing ½-in. shrink on the diameter) was heated and driven onto the disk rim. They all waited for results—and the hoop parted at the weld. It was taken off and a piece welded in and reheated. Again the wait—and the hoop was too large and wouldn't squeeze. It was heated again and held on and galvanized iron shims were spaced around underneath until it began to pinch. All well so far—but then the cracks hadn't closed, so the pin couldn't be tight. Next, 2 short straps were made of ¼ by ⅝-in. iron and 4 holes drilled and tapped in the disk for ¾-in. cap screws. The straps



CRACKED CRANK DISK

were then drilled and bolted over the crack, as shown at X and Y. Here's the joke—the cap screws were too long, and after they were tightened up, were cut off with a cold chisel. Why didn't he have them cut off in a lathe and not pound them loose in the holes in the disk after they were in? But odd to state, it held together for about 2½ weeks, until another disk, shaft and so forth could be gotten ready. It pounded considerably and heated on the crank, but managed not to kill anyone.

The causes of those cracks are not known; perhaps the pin was too large for the eye, or more probably, the heavy doses of water the engines sometimes got. Yet, tell me what kept that pin from breaking out? I have wondered, did not the cushion afforded by that back pressure lessen the shocks at the ends of the stroke?

But ½ in. of shrink is too much on a 40-in. disk.

I. M. Coming.

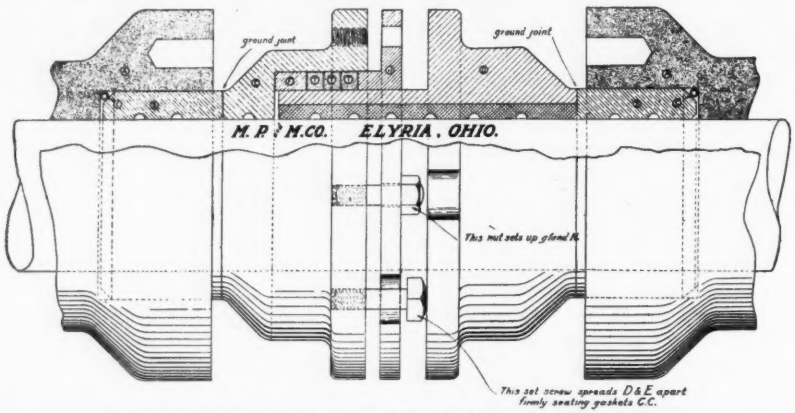
SOME OF THE CITIZENS of Armstrong, Ia., contemplate erecting a privately owned electric light and power plant, according to reports. They figure that they can furnish electricity to patrons cheaper than they are now paying and yet secure a profit for the company. It is understood the plant is to be operated in connection with the tile factory.—Swea City Herald.

METALLIC PACKING FOR PUMPS

MR. Waldron's letter on page 1090 of the November 1 issue, of Practical Engineer, leads us to believe that your readers might be interested in a packing for opposed cylinder pumps as shown in the cut herewith. In this arrangement no fibrous material comes in contact with the plunger and while we have not made any extensive friction tests on this, we find that where it has been applied on pumps, the throttle valve which formerly was opened 1½ turn, required only ⅓ of a turn to supply sufficient steam to operate the pump.

The tremendous friction and waste occurring in plunger pumps (particularly in the larger sizes, although the small sizes are nearly as bad), has often been the subject of comment by progressive engineers, but no remedy has seemed to be available in the past except to change back and forth from one type of fibrous material to another, made into various forms, but all of which were quite generally found to give about the same result as to friction after a more or less extended use.

It will be noted that this packing is designed for outside center packed pumps and is perfectly tight against the escape of fluid; hence, instead of a pump


ground joint
ground joint
M. P. & M. CO. ELYRIA, OHIO.
This nut sets up gland K
This set screw spreads D & E apart firmly seating gaskets C.C.

MARTELL METALLIC PACKING FOR OPPOSED CYLINDER PUMPS

of this character being a constant source of annoyance in regard to cleanliness, it becomes the cleanest and most noiseless machine in the plant. The increase of efficiency with the use of this packing is pronounced. It is also found that a pump is much more reliable and steady in action, and also that the plungers do not show any appreciable wear.— L. H. Martell, General Manager, The Metallic Packing & Mfg. Co.

DOES THE INDICATOR LIE?

IN the Oct. 1 number, Mr. Cultra made an attempt to explain my cutoff for a single eccentric Corliss Engine. It is a simple thing to try this test; simply tie up the catch block on one end some day when the load is such that one end will carry it, then after the governor becomes steady take the card, and if it does not show cutoff beyond ½ stroke add a few pounds of back pressure until it does, or you can make it cut off beyond ½ stroke by adding 8 or 10 lb. of back pressure alone, which will do the same thing.

It seems strange that there is so little experimenting among engineers, as it is one of the best ways of getting facts that one does not read in books. I am at a loss to understand the number of spring used in Mr. Cultra's high and low-pressure cards 2 and 3. Card No. 2 shows a very low receiver pressure, about 14 per cent of the steam-line pressure, while the low-pressure card shows an unreasonably high pressure in the low-pressure cylinder; even if measured with as light a spring as 10 lb. How does he get it? I am sure some data on these cards would be welcomed by the readers.

Will Mr. Cultra explain how the admission line in the low-pressure card shows about 12 to 14 lb. pressure above the atmosphere, and at best, card No. 2 only shows about 5 lb. as his receiver pressure, which should be less in the low pressure rather than nearly 3 times more? A little light turned on these cards would be interesting. A. C. Waldron.

CHECK VALVE PROBLEM

UNDER the caption of "Boiler Questions," in the Oct. 1 issue, Mr. Fischer solves a problem regarding the pressure on each side of a check valve in a feed water line with a boiler pressure of 100 lb. per sq. in., and a disk 2 in. in diameter with a diameter of 1.82 in. exposed for pressure from pump, Answer wanted: Pressure in pounds per square inch on the under side of the disk.

Not being handy at figures, I do it in the following manner:

$2^2 \times 0.7854 = 3.1416$ sq. in. area to boiler.
$1.82^2 \times 0.7854 = 2.60$ + sq. in. area to pump.

.5416 sq. in. excess area to boiler.
100 lb. per sq. in. boiler pressure.

54.1600 lb.

We have 54.16 lb. to be split up into equal parts for the area in square inches of the bottom or pump side, so $54.16 \div 2.60 = 20.83 +$ lb., $20.83 + 100 = 120.83$ lb. per square inch to balance the pressure without taking into account the weight of the disk and the water upon it.

$2.60 \times 120.83 = 314.21 +$
$3.14.16 \times 100 = 314.16$

To bal. .05

With two 250-hp. water-tube boilers on the line, evaporating 35,000 gal. water in 24 hr., at 140 lb. pressure, I decided to see what pressure the 8 by 5 by 10 in. duplex feed water pump was working against. Taking the gage from the fire line, I connected it in with the master gage and found it 4 lb. off; I then

connected it up with the discharge side of the pump without shutting the pump down, opened the ¼-in. valve very carefully, so the gage hand would not throw too strong and was surprised to see that it only registered 145 lb. I then measured the check valve on the dead boiler (the 3 checks are all the same) and found the side next to the boiler was 2.5 in. and the exposed side to the pump 2 in.; what pressure should the pump be working against at 140 lb. pressure?

I would say that the pump would be working against a head of 140 lb. plus the friction and the weight of the column of water which, in this case, was about 14 ft., but as the master gage was only about 6 ft. above the discharge of the pump, and I set the pump gage on a level with it, the head would only be 6 ft. As to the check valve, it is raised from its seat when the pump is first started and the area is then equal both to the boiler and pump, so the pressures should be nearly the same with steady operation.

ARRANGEMENT OF BAFFLES; HEIGHT OF WATER;. LOCATION OF SAFETY VALVE

LOOKING over a few back numbers of Practical Engineer, I found 2 interesting pages, 640 and 641, in the June 15 issue. F. J. relates some difficulties he experienced in connection with a water-tube boiler. His case is not the only one where the boiler room is built first and than an attempt made to place equipment sufficient to deliver a certain amount of power, and as might be expected the results will not be satisfactory.

F. J. does not state the size of the other 2 boilers connected to his stack, but evidently his draft is not what it should be to get the 150 hp. with the original grate area. If there had been some means to increase the draft for this new boiler, it would not only have delivered the required power but would no doubt have done so as economically as is done with the present arrangement.

To produce 150 hp. requires about 560 lb. of coal per hour if we figure on a basis of 8 lb. of evaporation per pound of coal. With the orignal grate area of 24½ sq. ft. it would be necessary to burn about 23 lb. to the sq. ft. which can ordinarily be done with 0.5 in. of draft in the uptake.

Moving the bridgewall so far back makes the second pass too narrow just beyond the bridge wall and I think it would be advisable to move the second baffle a foot towards the rear water leg, when the gases reach this pass they are considerably reduced in temperature and volume, consequently this pass can be a little narrower. To help matters still more, it is not necessary to run the second baffle clear down to the last tube, if it ends on the second or third tube from the bottom row the lower tubes will receive their share of the heat just the same. To keep the front baffle from burning out, it may be better to place it as shown on sketch.

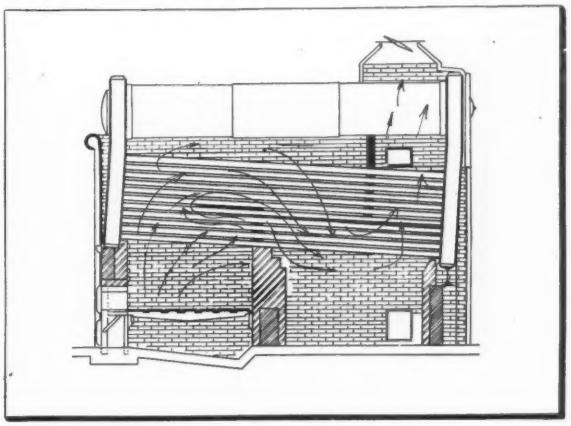
I do not think the priming that followed the burning out of the front baffle was caused by rapid circulation as F. J. suggests. It is more likely the generation of steam in the lower row of tubes was so rapid when these tubes received the full benefit of the flame that the water was thrown violently up in the legs, causing the priming of which F. J. speaks.

J. R. wants other engineers' opinion as to how many gages of water to carry in a return tubular boiler. If J. R. had stated his question thus, how high should the water level be kept over the top row of tubes, he would come nearer to it.

The writer has seen columns set so high that half a glass or 2 gages would mean practically no steam space at all, again they have been so low that 1 gage just about covered the tube.

Find out just exactly the location of the column or combination in relation to the top row of tubes, then carry the water so that it stands 4 or 5 in. above the tubes and keep it there. The less water the drier the steam and the easier it steams. Of course, there are exceptions to this practice as for instance when the load is irregular and it therefore is necessary at times to store up energy for the next heavy pull.

C. A. M. wishes to know what the effect will be of placing the safety valve at a distance from the boiler. The effect will be unsatisfactory all around. When the valve blows off, it will most likely set up



ARRANGEMENT OF BAFFLES SUGGESTED

a racket that will be anything but agreeable and the best valve in the market will be ruined in a short time, as the pulsation set up by the sudden decrease and increase of pressure in the pipe connections will hammer the best valve seat and disk out of shape.

Before the valve lifts, there is a pressure in the full length of pipe equal to that in the boiler, as soon as it lifts, this pressure is reduced in the end of the pipe next to the valve, and the tension of the spring will reseat the valve if only for a moment, or until the rush of steam from the boiler has again built up the pressure, this time a little higher than the boiler pressure on account of the acceleration, then the valve lifts again and the operation is repeated.

The connection between the valve and the boiler can never be too short. R. Cederblom.

REFITTING A MAIN BEARING

THE following description and illustrations will show what happened to a large main bearing on a Corliss compressor which was allowed to run hot at this point. The bearing was made of bronze and the heating caused the quarter box to spring and, when put in the lathe to rebore, the surface presented a bearing as shown by the irregular space outlined at M; consequently, a greater portion of the bearing was not touching the shaft at all. The bearing could not be made to run cool, so it had to be removed and be

rebored and fitted; this was done by clamping the section together, as shown in Fig. 2.

To have a sectional bearing of this kind fit properly in the engine and run cool is quite a particular piece of work, so in order that the work should come out right it requires much care in the setting up of the pieces on the lathe. The bottom section must be set so that the surface H, Fig. 2, is perfectly in line with the boring bar in the lathe, otherwise this will not come back right when placed in the engine frame; then it is quite as important to line the side sections for boring, parallel with the wedge surface C-D. If the bearing is not lined by this before boring, it is likely to give trouble when placed back in the engine.

It is not safe to set the bearing section from the point F, as this may not be true with the wedge surface; this flange is only intended to hold the bearing section in place. There have been many bearings that have given much trouble from this point of neglect

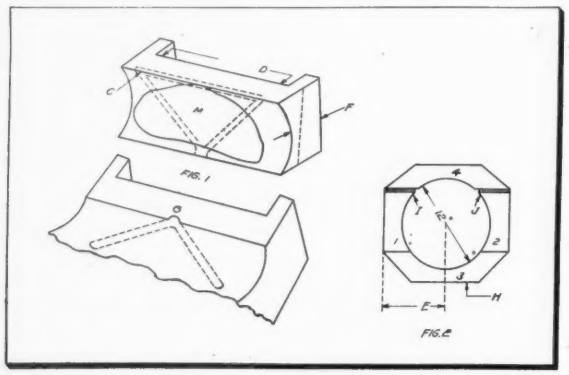


FIG. 1. DEFECTIVE BEARING
FIG. 2. BEARING ASSEMBLED FOR REBORING

alone. Should we fail to get our bearing set in line with the wedge surface, the bearing would heat when replaced in the engine, due to the fact that it would be brought up tight against the bearing at the 1 end.

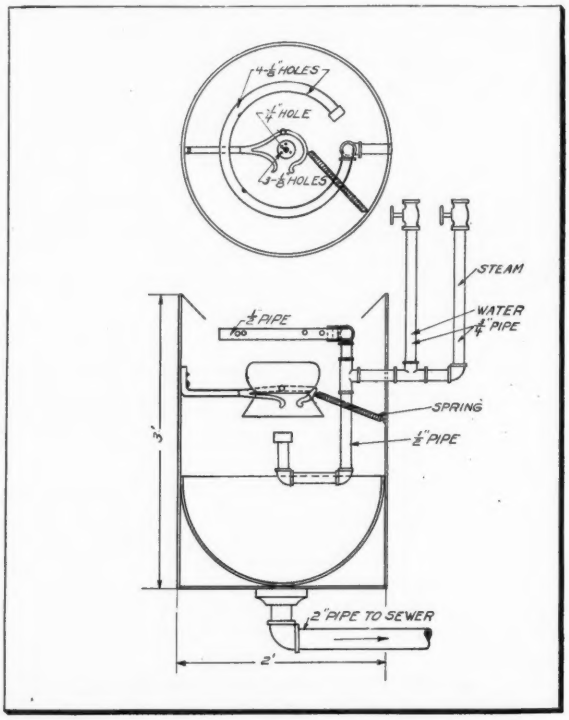
Sections Nos. 1 and 2 should be carefully set for alinement; therefore, to be sure that the distance C-D is right, he must likewise get the distance E to an exact measurement. We should put our liners in place and then set our top section No. 4 in place, so that we can clamp the whole; if an engine shaft calipers 12 in., we should bore our bearing at least 12 in. plus 1/64 in., so that the points I J don't touch, as this is what usually causes a bearing to heat up first. The best plan is to relieve the corner, as shown by the dotted lines in Fig. 1, and then run a good deep oil channel, as shown, bringing it to the center and letting this enter at G in the bottom section; this will reverse the flow of oil on the journal and give a complete wiping effect.

It is quite important to cut the oil grooves in a bearing deep and smooth, so that lint will not follow and hang in them. The opposite half of the bottom bearing should have the grooves cut just as shown at G; it is claimed by some that the portion that carries the load should have no oil grooves, but practice teaches us differently. I have had large bronze engine bearings that could not be run cool and by cutting the proper oil grooves in the bottom section, the bearing would run nicely. C. R. McGahey.

CUSPIDOR CLEANER

WE have in our factory over 400 cuspidors; it took one man 5 hr. a day to clean them by hand, so I made one of these cleaners. He cleans them all in 1 hr. now.

I took a galvanized tank, 2 by 3 ft. and sweat a 2-in. flange on the bottom for the drain; also ½ and ¾-in. pipe for the cleaning parts; ¼ by 2-in. strap iron and ⅜-in. cold rolled steel for the holder, and one ¼-in. woven spring. The outside cleaner has 4 ⅛-in. holes; the inside has a pipe cap with ¼-in. center hole and 3 ⅛-in. holes on the edge.



PLAN AND ELEVATION OF CUSPIDOR CLEANER

I made a wooden sewer box to set the cleaner in, and a round wooden cover to fit on the tank. The best way to clean them is to turn on the steam, then water and steam, then cold water, then your cuspidor is steamed, scalded and cooled off. Eli Williams.

FILING MAGAZINE CLIPPINGS

AFTER I had taken Practical Engineer, and one other magazine for some time, I realized that to preserve them in their original form would necessitate renting storage room. I also realized the wellnigh hopeless task of hunting out any desired information under such conditions, so I devised the following plan; while it may be old to some, it may also be of use to others.

I started by procuring a common Falcon letter file, 11 by 12 in. by 3 in. thick. These files contain a series of pockets which are lettered in alphabetical order. I also procured a number of envelopes 4 by 9 in., which fit nicely in the pockets on end, 2 abreast. Not being possessed of a typewriter with which to mark the envelopes, it was a simple matter to procure the subjects required by clipping them from

the advertisement column and pasting them on the ends of the envelopes, which made a very neat job; in fact, a friend wanted to know where I got the envelopes with the subjects stamped on them.

These envelopes, after they are placed in the file with the subjects out, are in plain view when the file is opened and spread out like a fan, each subject placed in its proper class; as, for instance, "Engine Testing" would be placed in the pocket marked E. It's a very simple matter, provided you want to use this plan on a larger scale, to have a separate file for each main subject, then subdivide it into its proper classification. E. C. B.

HOME-MADE SERVICEABLE LEVEL

AT the plant, we needed to do some leveling in a curved line several hundred feet long. We had no surveyor's level, only an ordinary level about 2 ft. long. It looked like a long job, so we looked for a quicker way.

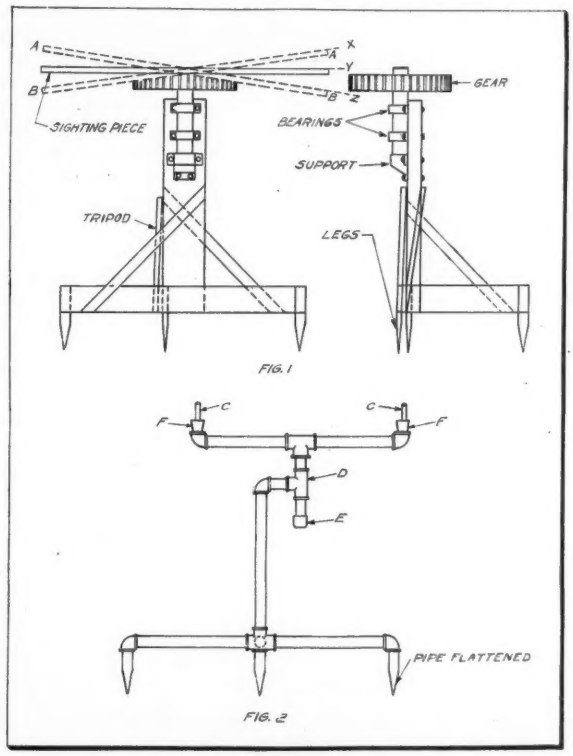


FIG. 1. AN IMPROVISED LEVEL
FIG. 2. HOME-MADE WATER LEVEL

In the scrap pile, I found an old gear wheel, about 10 in. in diameter, fixed on a shaft about a foot long. as shown in Fig. 1, this was mounted on an improvised tripod, using blocks of wood for hearings for the short shaft. A straight piece of wood about 10 ft. long was then fastened across the gear wheel in a position as A-B.

By looking along the piece on top, you will sight a place, as Z. Now reverse the piece by turning in the bearings, and sight again. You may see a place like X. Now adjust the piece by blocking up on the gear, or by cutting away the wood until you sight the same spot as Y, both before and after reversing. The level is now ready for use.

Put an ordinary level on top of the sighting piece, and level the tripod both ways by pushing the legs into the ground, or by blocking up if on a hillside. As soon as level in all positions, you may sight in any direction, and always have a level line of sight.

Another device which is more accurate, is what is known as the "water level." It may be made from pipe fittings, as shown in Fig. 2. C is a gage glass, fastened with a suitable stuffing gland F. D is a tee, which supports and also acts as a bearing for the upper parts of the level which is filled nearly full of water. The upper part of the level is stopped at the lower end by a cap E.

The water in the glasses will always be level, and the level is used by sighting across the surface of the water in the glasses. If a colored fluid, that will not stain the glasses, is used, or if a fine line of paint is made on the glasses on the sides farthest from the bearing, sighting will be easier. Care must be taken not to spill the water. Edward Skillman.

CHANGING LIGHTING CIRCUIT

THE diagram shows how our street lighting system was connected when I took charge of the plant a year ago. There were 24 52-volt, 32-c.p. lamps connected in series, and as nearly all of the lamps were on one street, I decided to do a little experimenting, so I connected all of the lamps in one of the series

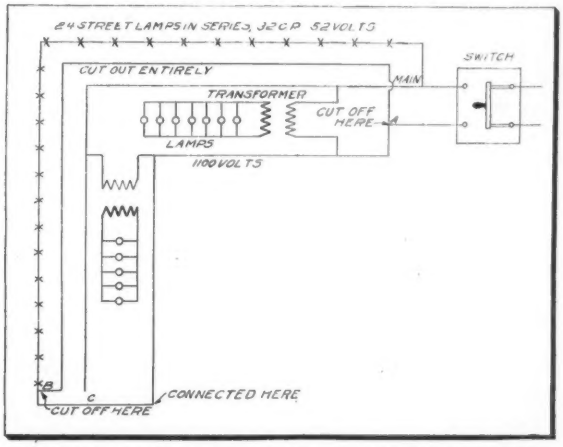


DIAGRAM OF CONNECTIONS FOR SINGLE-PHASE SYSTEM

wires and cut the other one off at A and B in the diagram and connected the one with the lamps on it to the opposite primary at C, and when I put the street light switch on, the lamps burned all right and are still working.

By connecting them up this way we are able to cut out one side of the old series circuit and use the wire for other purposes. Bethel Smithers.

A FURTHER STEP toward the completion of the huge plant of the Milton-Bradley Co., at Springfield, Mass., has been taken in starting work upon the foundations of the addition, to be known as building No. 6, adjacent to building No. 8. The latest addition will be of brick, 124 ft. long by 60 ft. wide. It will be of heavy mill construction and consist of 6 stories in addition to a basement. The foundation is of concrete and it is upon this last that the work of construction has been begun. The total cost will be about $55,000. The addition will be one story higher than the old building.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Lever Problem

WHAT force can a lever, arranged as shown in Fig. 1 exert in a 2-in. cylinder fitted with a piston?

F. C. B.

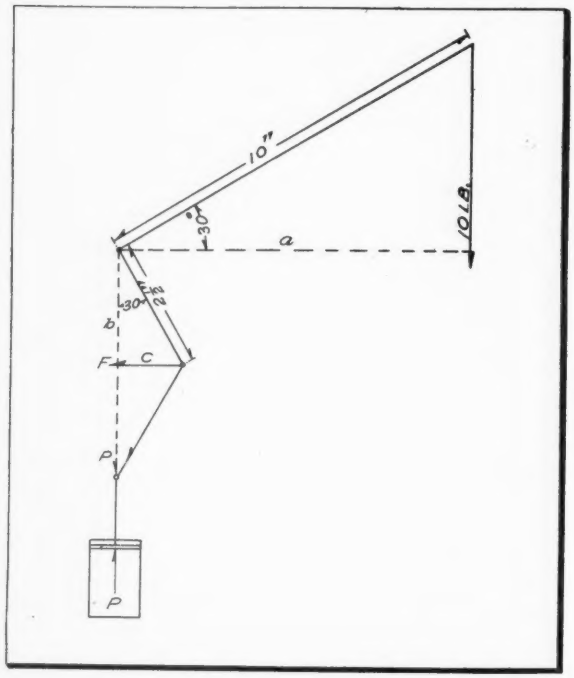


FIG. 1. DIAGRAM OF LEVER PROBLEM

A. The working out of this problem is shown in Fig. 2.

A. L. R.

Massachusetts Examination Questions for Third-Class Engineer's License

IF you were in the country and had a set of crank pin brasses to babbitt, how would you proceed to do it?

2. In babbitting crank pin and wrist pin brasses what effect does it have on piston and engine?
3. Would you heat the brass? How?
4. Suppose it was a crank shaft journal?
5. Would you not burn the paint off?
6. Are they ever poured cold?
7. How would you proceed to babbitt a shaft bearing?
8. How much would you put in?
9. How would you regulate the thickness?
10. How do you take up wear on brasses?
11. Does a centrifugal governor change lead or lap?
12. Does it change travel of valve?
13. Is there a manhole in a Manning boiler?
14. How would you measure pitch of socket bolts on water leg?
15. How do you find pitch for rivets on longitudinal joint for lap and butt joints?
16. When you babbitt crank pin journal, what would you look out for?
17. How would you proceed to pour box?
18. How would you put shaft in alinement?
19. Do you temper piston rings?
20. What is meant by O. G. ring? E. G. S.

A. In answering the first and some of the following questions, it must be understood by the reader that it is not possible to give an answer that will apply to all cases, or even to the one in question, unless one is more familiar with the conditions to be met. The question of babitting a set of crank pin brasses in a locality where facilities for doing such work are meager, taxes one's ingenuity somewhat to do a creditable job with the material at hand.

Assuming that there are no means at hand to babbitt the crank brasses on a mandrel of any kind, it is necessary to babbitt them in place. While the brasses are being stripped of the old babbitt, hang a redhot ring on the crank pin so as to warm it considerably, but not enough to affect the fit of the pin in the crank disk. If there are any holes in the pin to feed oil from a center crank oiler, plug them temporarily with wooden plugs.

$a = 10 \cos. 30°$
$= 10 \times .866$
Wt. Moment $= 10 \times a = 10 \times 10 \times .866$
$= 86.6$ in. lb.
F Moment = Wt. Moment
F Moment $= F \times b$
$b = 2.5 \cos. 30°$
$= 2.5 \times .866 = 2.16$
Moment $= F \times 2.5 \times .866$
$F \times 2.5 \times .866 = 86.6$
$F = \frac{86.6}{2.5 \times .866} = \frac{100}{2.5} = 40$ lb.
$P : F = b : c$
$c = 2.5 \sin e\ 30° = 2.5 \times .5$
$P \times C = F \times b$
$P = \frac{F \times b}{c} = \frac{80 \times 2.5 \times .866}{2.5 \times .5}$
$= 69.280$ lb.
Area for 2" Diam. $= 3.1416$ sq. in.
press. per sq. in. $= 69.28 \div 3.1416$
$= 22$ lb. per sq. in.

FIG. 2. SOLUTION OF LEVER PROBLEM

Cover the pin with a coating of lampblack and oil, or white lead, taking care not to apply more than just enough to cover the metal. Assemble the crank and brasses in place, having the crank pin located, preferably on the center, and by shifting the connecting rod endways, and up and down, block the rod solidly so that the pin will be in the center of the hole.

A shim about ⅛ in. should be inserted between the 2 halves of the box, and the wedge drawn up snug. This shim should touch the pin and shut off each half of the box from the other. Some means must be supplied to pour the babbitt, either by pouring through the oil cup hole and afterwards drilling it out, or drilling a hole in the top of each brass with a small hole on the opposite for a vent.

Cover all openings through which the molten metal can escape, with moist clay (not wet), putty or old pipe covering ground up and mixed to a stiff putty with oil. While these preparations are taking place, have the babbitt melting, so that when you want it, it will be just about warm enough to char a dry pine stick, and a little warmer, if you have to carry it far or the weather is cold, which will tend to cool off the warmed pin very quickly.

When all is ready, pour the babbitt as quickly as possible till it fills the pouring holes completely. This is to allow for the contraction of the metal in cooling. When the work is cool enough to handle, remove the brasses and cut the oil grooves. Then scrape the brasses to a fit by using a little black lead on the pin and scraping the babbitt till it shows a good bearing all around, and afterwards relieve the babbitt a little, near the joint, to prevent cracking if the pin warms up and expands.

Remove the wooden plugs from the oil holes (if any), assemble the whole job, adjust the crank brasses in the usual manner, and after moving the engine off the center the job is completed.

2. In babbitting the brasses on the crankpin and crosshead pin, it frequently interferes with the striking clearance in the cylinder, and care must be exercised to maintain an equal clearance, either by adjusting the piston rod in the crosshead to suit, after the babbitting is completed, or else by changing the shims at the pins. The clearance can also be equalized by careful adjustment of the reciprocating parts before babbitting.

3. If it is a possible thing to do so, heat the brasses and pins before babbitting, for to do so, prevents chilling the molten metal and consequent cold-spots. A common blow torch is a convenient means of heating crank brasses preparatory to pouring, and can be secured in nearly every community now. Another good way is to heat large pieces of iron and support them under or beside the crank and brasses for a little while before pouring.

4. A crank shaft journal can be heated by any of the above methods, only that if red-hot irons are used, have them as bulky as can be handled conveniently. See that they are free from scale or dirt, and lay them lengthwise of the shaft. This will heat the journal enough to make a good job of it.

5. Paint on an engine is a decoration and not an essential. The engine will operate just as well without paint. However, if care is exercised, heating journals or pins preparatory to babbitting, can be accomplished without marring the finish of an engine.

6. Yes.

7, 8 and 9. First, remove all old babbitt from the shells, and after placing the bottom shell in position, adjust the shaft so it will be level and in line with the center line of the engine. Space the shell equally on each side of the shaft, so that the babbitt will be the same thickness all over the shell. See that the molten metal cannot escape past the ends of the shell. If there is a collar on the shaft, this on one end and the crank on the other, will usually suffice, although on an old engine there may be considerable wear, which can usually be filled in with millboard or any other convenient method.

Arrange suitable dams to prevent the babbitt running off the shell into the oil cellar. When everything has been prepared, warm the shaft in the most convenient way, place the dams quickly in position, and when the babbitt is warm enough to pour, do so as fast as possible. If the bearing is so large that several ladlefuls are needed, have 2 men to pour, so that there will be a continuous stream of molten metal going in all the time until completed.

When cooled, at least partially, raise the shaft and trim up the shell and cut the oil grooves. Put the shell in place and let the shaft down; then check up the leveling and alinement. In pouring the side shells, next see that you make allowance for as much adjustment as you can. Use a metal shim as thin as possible (stovepipe iron will do) between the side and bottom shells to prevent the babbitt fusing together.

All engine shaft bearings should have not less than ⅜ in. of babbitt for small engines, and up to ⅝ in. for the largest engines. In pouring any kind of bearing, it is best to arrange so there will be room to pour in a little in excess of what is required. This allows not only for shrinkage, but also for the impurities in the metal to float to the surface, where they are removed with the excess metal.

10. There are a great variety of ways to take up wear on brasses, but nearly all have some form of a wedge adjustment, depending on the service, and also on the designer of the engine.

11-12. On an engine using a single valve controlled by a centrifugal or inertia governor, lap, lead, release and compression, as well as valve travel, are all changed with every change in load conditions, though some changes are more marked than others.

13. There is no manhole on a Manning boiler, as there is no space in any part of it but what is occupied by tubes and staybolts. They are sometimes made with large sized manholes to permit of a closer inspection.

14. Staybolts are spaced about 5 to 6 inches apart and are of a size so that the strain on each one will not exceed 6000 lb. per square inch at the base of the thread. While staybolts would stand considerably more than this in a straight pull, yet there is more or less distortion due to unequal expansion and contraction which must be guarded against. This is sometimes so great, especially in the waterlegs of fireboxes, that a socket bolt is used in place of a solid staybolt, which permits more freedom of movement.

15. In determining the pitch for rivets for a longitudinal lap joint, the first thing is to select the proper size of rivet, which for the usual small and medium sizes of boilers of pressures up to 126 to 160 lb., has been found by long practice to be as follows:

For ¼ -in. sheet, ⅝ -in. rivet.
For 5/16-in. sheet, 11/16-in. rivet.
For ⅜ -in. sheet, ¾ -in. rivet.
For 7/16-in. sheet, 13/16-in. rivet.
For ½ -in. sheet, ⅞ -in. rivet.

Then having selected the proper size rivet, the rivets are pitched at a distance so that the shearing strain of the rivet will be about equal to the tearing strain of the sheet between the holes. Owing to the great variety of conditions to be met in boiler construction, many other things must be considered also in determining the pitch of the rivet, such as, workman-

ship, lateral stiffness of the plates, whether the boiler is for stationary use where there are no operating strains or for marine or railroad service, where operating strains are very severe, and several other reasons.

16. See that the shaft is level and that it is perpendicular to the center line of the engine.

17. See answer to first question.

18. Remove the connecting rod, crosshead, and piston and run a line through the cylinder, setting it central with the counterbore. If the shaft has a crank disk, by measuring from the line to the edge of the disk on both sides of the shaft, will show if the shaft is out of line. If it is, then by shifting the outboard bearing forward or back, as is required, the shaft can easily be put in line.

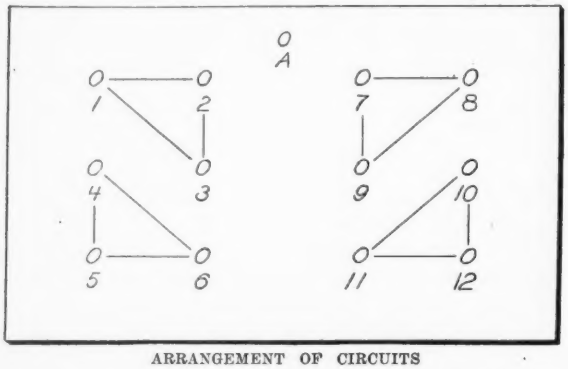
19. No.

20. An O. G. ring (or ogee) is that irregularly flanged ring on a Manning boiler which is riveted to, and connects the upper shell which surrounds the tubes, to the lower and larger outer shell that surrounds the firebox. G. H. Wallace.

Transmission Line Difficulties

I AM in charge of a 6600-volt, 3-phase, 60-cycle, a.c. power plant that supplies power to coal mines. The load varies from 2 kw. to 1200 kw. all day. The transmission line is built as shown in the figure in which A is a barbed wire ground line to pick up lightning, which extends over about 2 miles of a 6-mile line; 1, 2, 3 is No. 1 circuit; 4. 5. 6 is No. 2 circuit; 7, 8, 9 is No. 3 circuit; 10, 11, 12 is No. 4 circuit.

The pole line is 6 miles long. None of the 6600-volt transmission lines are transposed. Circuits 1, 2, 3, 4 run one mile on the poles; circuits 1, 2, 3 continue 2 miles farther; circuit No. 1 continues the 6 miles. Guy lines on the poles are fastened as close as 8 in. to the 6600-volt lines, and have no break insulator in them. A telephone line runs on the same poles part



ARRANGEMENT OF CIRCUITS

of the way, jumps to an independent line for 2 miles and comes back on the power lines again. This telephone line sings badly. The president of our company has put it up to me to put it in shape soon. We should like to get the following information:

1. A clear explanation of induction as applied to a 6600-volt power line.

2. What effect does induction have on the generator in a power house? Does it represent loss?

3. Should 6600-volt power lines be transposed, and, if so, why?

4. What use are drain coils on a telephone circuit, and what is their effect? In other words, how do they control a singing telephone circuit so as to eliminate the noise?

5. Is it possible to construct on the poles described above, under the wires, a telephone line so that the singing will be stopped without the use of drain coils? If so, how far below the power lines should the telephone line be run; how often should it be transposed, and how should it be transposed? Should it be transposed by using transposition insulators, or by crossing wires between poles?

6. If the wires are strung on brackets should the brackets be the same distance from the lower lines on each side of the pole and on each pole, or, if the brackets are both on the same side of the pole, should the brackets be the same distance apart on each pole?

7. Will a 110-volt a.c. line near the telephone line affect the telephone line?

When circuit No. 4 was in course of construction, power was on circuits 1, 2, 3. The induction was so bad that the men could not work on circuit No. 4 except on Sundays, when the power was off.

The company wants to build 10 miles more of telephone line, and, if possible, they want to run it on power line poles. They want to avoid erecting a special telephone line if possible, so you see much depends upon getting the line now in operation, in good shape. C. N.

A. Your questions involve a good deal of theory of alternating currents and mathematics, and we must answer them rather briefly, but will refer you to sources of further information.

1. Induction is due to 2 things:—First, the mutual inductive action between wires carrying currents. The magnetic field which surrounds every wire, spreads out so that it cuts across the neighboring wire, and this cutting across induces an electro-motive force in the second wire. In the same way that action goes on in a transformer, only to a less degree. The amount of this action depends largely on the amount of current flowing; and also is inversely as the distance between wires, since the magnetic field is stronger close to a wire than it is farther away.

The second effect is due to capacity—that is, a charge of electricity on any conductor tends to induce a charge of opposite character on any other conductor placed near it, what is known as condenser action. This effect is in proportion to the voltage on the line, and is also inversely as the distance between the conductors.

The way to cut down this inductive effect is, therefore, to keep the wires well apart, and where there are 2 circuits (not 2 wires, but 2 complete circuits) run parallel to each other on the same pole line, to transpose the wires in these circuits at about every mile. This should be done by transposition insulators on the poles, as transposition between poles is likely to increase the possibility of a swinging contact between wires, which would short circuit the system.

This is the basis of induction, but it is not nearly as simple a problem as might be inferred. You will find a further treatment of it in "Bell's Electric Power Transmission."

2. Induction represents loss in capacity in the generator, and also calls for an increased voltage. The effect of induction in the line is to produce what is called "impedance dropping"—that is, the generator must furnish enough voltage to overcome the voltage set up by induction; just the same as it must furnish voltage enough to take care of the resistance drop, in addition to that which is to be delivered at the end of the line. This means that generator voltage must be higher than it would be without induction.

which means, of course, increased excitation and an increased loss in the field windings.

Also, the induction increases the angle of lag between the electromotive force and the current, and therefore decreases the power factor. This means that to deliver a certain power, the generator must furnish a larger current than if there were no induction and no lag, so that the maximum power which the generator can furnish when carrying the largest current which the windings will safely stand, is less than it would be if the circuit were non-inductive.

3. This is really answered in the first question, if there is a single power circuit. In your case, for instance, the number one circuit only, there is no need to transpose the power wires; but for the distance over which several circuits are carried on the same set of poles, the wires should be transposed every mile, in order to cut down the mutual induction between circuits.

4. We do not know the drain coil by that name, but presume that you refer to choke coils placed around the wire to neutralize the inductive effect from the power circuits.

The singing in the telephone line is due to the alternating electromotive force set up by induction from the power wires. The drain coils produce an electromotive force which neutralizes this.

5. It would seem quite possible to install telephone lines on the same poles as your power circuits, which would be satisfactory for use of the power company's employees, but it would not be wise to install such lines for public service.

In a high voltage system there is frequently a capacity effect, as noted in answer 1, between the power circuits and the telephone circuit, which may raise the voltage of the telephone wires up to from 20 to 130 volts above that of the earth; and to make the use of the telephone lines safe under such conditions, all parts of the telephone line, including line wires, instruments, and the man who is using the telephone, must be insulated from the earth, so that no discharge can take place from the line through his body. This means that all apparatus inside of buildings as well as outside, must be insulated against a voltage of at least 200, and the user of the apparatus must stand on a platform insulated from the ground.

To avoid the singing effect, the telephone wires should be transposed every 500 ft., and should be kept at least 3 ft.—and better 5 ft.—away from all power circuits. The transposition should be made on the poles rather than between poles.

6. It makes little difference whether the telephone wires are on the same side of the pole or on opposite sides, but the wires should, so far as possible, be kept at a uniform distance from the power circuits, in order that the transposition may neutralize the inductive and capacity effects.

7. A 110-volt power circuit, if placed near to the telephone line, would have the inductive effect which would produce singing; but would not have a capacity effect to produce a voltage on the telephone line with respect to earth.

With regard to the construction of your pole line, while it is not likely that current will jump from the power circuit to the guy line over an 8-in. space, yet it would be much better if this space were larger, or an insulation break put in the guy line. During a heavy shower there might be a good possibility of the current jumping over.

In connecting up telephones to the system, the bridging phones should be used rather than series phones, and the connections should be made at the even transpositions. Where necessary, a special transposition should be made, in order to have this connection of the phones come in right; otherwise the transposition will not neutralize the singing effect.

Besides the book which I have already mentioned, there is a paper by P. M. Lincoln, on "Power and Telephone Wires," presented before the American Institute of Electrical Engineers, March 27th, 1903. You can get a copy of this from the Institute, 29 West 39th St., New York City. I do not know exactly the cost, but if you send them 50 cents they will return you whatever difference there may be.

I would advise, also, that you study some parts of the book on "Telephone Engineering," by K. B. Miller.

A. L. R.

Horsepower of Motors

UNDER my charge there are 3 motors, one direct-current motor and 2 3-phase induction motors. The direct-current motor is rated at 140 hp., 575 volts, 230 amp.; the alternating-current motors 33½ hp., 2300 volts, 8 amperes, and 200 hp., 2200 volts, 50 amperes respectively. Kindly show me how to figure the horsepower of each. W. E. R.

A. To figure the horsepower of a direct-current motor, multiply the volts by the amperes and divide the product by 746, which represents the number of watts in one electrical horsepower. This result should be again multiplied by the efficiency of the motor, which gives you the actual horsepower of the machine.

In your case, it is $(575 \times 230) \div 746 = 177.2$. As you do not give the efficiency of your motor, divide the rating of the motor, 140 hp., by the product of the volts and amperes, divided by 746, which gives approximately 79 per cent efficiency.

The other 2 examples are worked out in a similar manner, with the exception that in a 3-phase alternating-current motor, the product of the volts and amperes should be multiplied by 1.73, by the power factor to secure the actual horsepower.

$$\frac{2300 \times 8 \times 1.73 \times \text{P F}}{746} \times \text{Efficiency.}$$

N. G. M.

Idler Pulleys

ARE idler pulleys which run on the outside or opposite side of the belt from the transmission pulleys usually made with straight or crown face? And why? W. M. F.

A. Idler pulleys which run on the outside or opposite side of the belt from the transmission pulleys are made with a straight face. If a crown-faced idler is used and it is not exactly centered with the driving pulley, it would have a tendency to shift the belt from one side to the other. N. G. M.

Pressure on Cylinder Head

THE question was asked, would there be any more strain on the bolts when running with 100 lb. gage pressure than there would be when not running. Running, there was 500 lb. tension on one stud drawn up by the nut. If so please explain why. Also should like to hear from the readers of Practical Engineer.

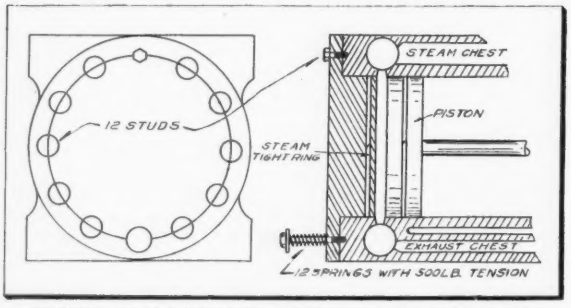
A. G. P.

A. Any vessels, such as a boiler, tank, or the cylinder of an engine, are designed to withstand a certain amount of pressure with a given factor of safety. If a boiler of a given size is to carry but 100 lb. pressure, it is not constructed of such heavy material as one which is intended to carry to 200 lb. pressure, other things being equal.

It is the same way with the cylinder of an engine. One that is to carry, say, 200 lb. initial pressure, must of necessity, be constructed of heavier material than one that is to withstand an initial pressure of 100 lb. Examine some of the engines that were made 50 or 60 yr. ago, when 40 lb. was considered an enormous pressure. They are very light from a modern point of view.

Now, since it is evident that the cylinder must be thicker for a given size to meet this increase in pressure, it is reasonable to believe that this increase in pressure acts on the head of the cylinder as well as upon the walls.

For the purpose of illustrating, let us assume an engine cylinder 16 in. in diameter, the area of which is 201.06 sq. in. To simplify matters, let us call it 200



METHOD OF ILLUSTRATING PRESSURE ON STUD BOLTS

sq. in. Assume also that the steam pressure is, say, 100 lb. Then the total pressure on the inside of the head will be 20,000 lb., when steam is admitted. To further bring out the point to be illustrated, let us suppose that the cylinder has no counterbore, that the cylinder head is an easy fit in the cylinder and that it is steam tight without a gasket. (See sketch). Then we can draw up on the nuts until the head seats properly, but without putting any strain on them; in fact, after drawing the head to place, slack the nuts until they are loose. We now have conditions to suit the point to be brought out.

The engine is at rest, therefore there is no strain on the studs, which are in the cylinder for the purpose of holding the head on. Now place the engine in operation with 100 lb. initial pressure. What happens? The instant that the steam valve opens and steam is admitted at a pressure of 100 lb., there is a pressure of 20,000 lb. on the head tending to force it off, and this strain must be withstood by the studs, each taking its share. This steam expands down to but a few pounds and then is exhausted, leaving the head, again, with no pressure on it.

Then suppose, as set forth in your question, that the nuts were drawn up each with a strain of 500 lb. Also suppose that there is a spring under each nut and that it is compressed to 500 lb. Then, for the sake of argument, suppose that the initial pressure, instead of being 100 lb., is 150 lb. This will give a total pressure of 30,000 lb. on the inside of the head, which is to be withstood by 12 studs and nuts which already have a strain of 500 lb. on each one of them. That will give a total pressure of 2500 lb. that each stud has to withstand, or 2000 more than there is on it already. What happens?

As soon as the pressure is high enough that the pressure on the inside is greater per stud (about 30 lb.) than the tension of the spring is on the outside, then the head as a whole will be forced outward and the springs compressed up to that point where such compression equals the direct pressure on the inside, either as a whole or per stud, it being remembered meanwhile that the head is a sliding steam tight fit in the cylinder. As soon as the exhaust valve opens and the steam is released, the pressure is reduced to nothing and consequently the head will return to its place where the tension on the spring is the same as it was before; viz., 500 lb. on each stud.

Thus it seems plain that pressure increases the strain upon the studs of a cylinder head. No one ever saw a cylinder head blow out when the engine was at rest; it always happens when the engine is in operation or at least partially so, in order that the necessary excess pressure in the cylinder may be formed by the piston compressing the mixture of steam and water until it exceeds the combined effort of the head and studs to retain it.

The question may be demonstrated along the lines as set forth above by adjusting the relief valve on a cylinder under steam. These valves are, as a rule, set about 10 or 15 lb. in excess of the running pressure, so that they will remain closed under all normal conditions, but as soon as water is drawn into the cylinder in such quantities that the pressure will exceed the limits of safety, the relief valve will open and relieve the cylinder of the excess pressure and prevent accidents.

To all intents and purposes, the stem of the relief valve is a stud used to retain a cylinder head, only this head is of such a size that it is the disc of the valve and the tension is formed by the spring. When the pressure is greater than the tension of the spring then spring compresses until pressure and tension are equal, and remain so until the pressure is reduced.

Watch an engine, pump or other similar unit in operation when the gasket is partially blown out under the cylinder head. Note that when steam is admitted, the ragged edges of the packing are blown outward, which shows that the strain placed upon the studs is not sufficient to withstand internal pressure.

The accompanying sketch shows a Corliss cylinder with a head equipped with a packing ring so that no gasket is necessary and the nuts on the studs need to be tightened enough only to hold the head in place but not to place any strain on the nuts. The sketch also suggests the manner in which spring is to be fitted to all of the studs. G. H. Wallace.

IN A PLANT in a paint factory where there are generating units of 150 and 400 kw., respectively, driven by cross compound medium speed engines, the coal used per horsepower hour is 15.72 lb. and the cost per kilowatt hour for operation is 3.36 cents. Another factory plant having 2 150-hp. return tubular boilers and 2 75-kw. generating units uses 7.91 lb. of coal per delivered horsepower hour, and the cost per kilowatt hour, including heat, is 2.9 cents. This cost does not, however, include the steam used for industrial work.

At a school plant having a 75-kw. generating unit and a 150-kw., the coal per horsepower hour is 37.9 lb., and the cost per kilowatt hour is 11.1 cents. C. E. N.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

What Caused Broken Flywheel?

THERE is located at this point a large sawmill, which has a daily output of about 70,000 ft. a day. They have a large slide valve engine, rated at 500 hp., to run this mill. In a large boiler house are 8 boilers, 5 of which are used to supply steam to this large engine, while the other 3 boilers are used to supply steam for the dry kiln.

This engine had a driving pulley 12 ft. in diameter by 30-in. face, and was run at about 130 r.p.m. The main line shaft, which this engine drove by belt, was 4 15-16 in. in diameter. On October 15 this driving pulley broke, doing a lot of damage, but luckily hurting no one.

One piece of this wheel went out across the mill, tearing down the big heavy line shaft, and bending it so bad that it was not fit for use. Another piece went over the top of the mill, tearing a large hole in the eaves of the filing room roof, which is at the very top of the building (it being a 2-story building, with the filing room on top), going clear across the building and falling on the slab conveyor about 30 ft. from the mill and about 80 ft. from the engine.

Another went the other way, going through the boiler room wall, which was made of brick, and hitting the safety valve on one of the boilers, breaking it off of the dome completely.

The third piece went out of the engine room roof, flying from end to end of the boiler room roof without even touching it and landing on the ground about 15 ft. beyond the building. The boiler room is about 30 to 35 ft. high and about 80 ft. long.

The hub even left the shaft, while the broken parts all showed fresh breaks. I would like to know the cause of this accident, if anyone can explain it. Some say the engine ran away, while others say it did not.

The chief engineer, when asked as to what he thought caused the accident, said that he had 2 theories: one, that the engine ran away; the other, that a few days before the accident a small bolt dropped out of the follower-head and being jammed between the follower-head and the cylinder head, strained the wheel so that it finally broke.

Provided the bolt did drop out of the follower-head, it seems to me that it would have done some damage to the cylinder head, as it is claimed that the bolt took up about 1 to 1½ in. of space in the cylinder.

Chas. A. Cooper.

Starting a Corliss Engine

IN the October 15 issue of Practical Engineer, R. D. asks instructions for starting a Corliss engine which I assume is a Corliss engine of the simple type. G. H. Wallace explains the subject very well but left out one thing of importance to a beginner. He says, when necessary to stop the engine close the throttle and let the engine speed gradually reduce until it is almost stopped, then by disengaging the hook rod and inserting the starting bar the valve gear can be worked by hand and by using good judgment the engine can be stopped with the crank pin on or near the quarter; from this position the engine can be easily started. If he does as instructed he can not work the valve gear as the steam hooks will not hook on the valves and before he can start the engine he has got to raise the governor up on the dog or restpin.

The correction I make is that before the engine comes to rest there is a dog or pin that the governor comes to rest on and it has got to be held up in place until the governor comes to rest, then by disengaging the hook rod the engine can be stopped any place. If this pin is not under the governor to hold it up the engine will stop any place regardless of the engineer. This has been my experience.

Martin McGerry.

Requirements for License in Massachusetts

A READER wishes to know in regard to the requirements for license in Massachusetts:—First, what subjects of general information and special knowledge are required in securing a second-class fireman's license; second, is it necessary to have knowledge of all types and kinds of water-tube boilers, and of other types of tubular boilers? Those who have taken such examination in Massachusetts will confer a favor by furnishing this information.

Engine Problem

I AM encountering some difficulties in the operation of a Rollins engine and should like to hear from some of the readers of Practical Engineer regarding the trouble.

In the old Rollins catalogs it states that the steam right and lefts should be such that when the block, connected to the end of the bellcrank and sliding in the stirrup, is in the center of its travel, a horizontal level line should cut the center of the pin holding the block in place and the center of the stud that the bellcrank turns on. On my engine the center of the block does not go much if any. H. C.

Compressed Air-Driven Pump

IN reference to the problem, "Compressed Air-Driven Pump" in the Nov. 1 issue of Practical Engineer, years ago I experienced the same trouble with a mine pump and cured it in the following manner:

I hung an old tin bucket on the nipple in the steam chest and kept a charcoal or coke fire in it. To give the fire draft I punched holes in the bottom and side of the pail. This device proved to be simple and effective. W. C. Schueler.

Cutting Keyways

SHOULD like some of the readers of Practical Engineer to explain a simple method of cutting keyways in the valve stems of Corliss engines. J. E. R.

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RULE OF THUMB HORSEPOWER

Frequently the question arises, "What is the horsepower of that engine?" Not the horsepower that it is developing, but its rated horsepower, and the question is usually asked by a novice who understands little about the factors involved.

Nobody who understands a steam engine would think of giving an answer or a rule to figure from bore stroke and speed; the steam pressure, cutoff, and for accurate results the compression, must be known, as is recognized in the rule involving m.e.p.

In the case of the combustion engine the factors are still more variable, for the kind of fuel, quality of mixture, compression pressure and ignition point, all affect the m.e.p., but because of the automobile rule, which considers only bore and speed, the idea has gone forth that a rule of thumb can be devised for any form of engine. In the automobile, gasoline is always the fuel, and the cylinders were nearly square at the time the formula was adopted and piston speed was somewhere near uniform. This condition no longer holds and the formula is practically valueless now even for automobiles.

While the rule proposed at the meeting of the National Gas Engine Association may be a reasonable average for small engines running on gasoline, it will certainly be in error by 10 per cent in many cases, and if applied to large engines, or those using gas or oil fuel the error will be much larger. The duty of engineers and engineering and kindred associations is to let the layman understand that rule of thumb engineering without judgment is as impractical as rule of thumb practice of medicine or law.

GAS TURBINES

It is but natural, in view of the success of the steam turbine, that effort should have been made to apply the same method to combustion prime movers; but there are not the same possibilities of economy with the two mediums.

In the reciprocating steam engine, a chief source of loss is the condensation of steam at admission and the effort is always to keep the cylinder as hot as possible. Also there is a great advantage to be gained by expanding the steam to very low pressures, which involves the use of high vacuum condensation and big cylinders. The steam turbine avoids the condensation, and by its high speed makes the low pressure energy available at a first cost that is not excessive, hence, there are good reasons for its use.

With the gas engine, the cylinder gets too hot and must be cooled to avoid preignition and injuring the material. Condensation cannot be applied to expand to pressures below atmospheric, and even if it could, the energy from such expansion is not so great as for steam. The only advantage for the gas turbine is, therefore its high power for small weight, which is offset by the complication involved in cooling the nozzles and blades. No possibility is apparent of thermal advantage from using the turbine, while its high speed is against it in the matter of connecting to driven machinery and in upkeep.

While it is interesting to know of progress being made as shown in Mr. Wagner's article, it is well to consider what practical benefit is to be gained from the gas turbine after we get it? With the same care to utilize the heat from jacket water and exhaust, would the gain not be greater with reciprocating engine than with the turbine, and a more satisfactory prime mover be obtained?

NEWS NOTES

AN ELECTRIC LIGHT PLANT is in course of construction at Upper Edgely, Pa.

A VENEER MILL is being erected at Montgomery Center, Vt.

EVENS AND HOWARD Fire Brick Co. of St. Louis, Mo., manufacturers of all forms and shapes of fire brick, have opened a sales office in the 1st National Bank Bldg., Chicago, room 1254, which will be in charge of H. E. Risher.

A NEW DAYLIGHT constructive factory building is being erected at Harrisburg, Pa., for the Elliott-Fisher Typewriting Co. It will be the first daylight factory to be erected in this section of the State and will be 250 ft. long, 60 ft. wide and 4 stories in height. It will be of concrete with steel window frames.

THE LANCASTER, WIS., ELECTRIC Light Co. is contemplating the erection of a much larger plant in the near future, to care for the increasing business of the company. The new plant will be built adjoining the present plant. The company expects very soon to have light and power lines running to Fenimore, Bloomington and Potosi.

THE DEPARTMENT OF ELECTRICAL ENGINEERING of the University of Illinois has added to its equipment a 200,000-v. testing transformer made by the General Electric Co. It will be used in studies of corona and other phenomena of high tension lines, the determination of the break-down point of oil and porcelain insulators, and in a study of the action of lightning arresters and other protective apparatus.

WE ARE ADVISED of the following recent appointments by the Magnolia Metal Co.: J. W. Wright, formerly salesmanager of Griscom-Spencer Co. has taken a position with the Magnolia Metal Co., as special representative on the Pacific Coast, with headquarters at San Francisco. Wm. H. K. Gamble, formerly Southern representative of Chas. A. Schieren & Co., will be the special representative of the Magnolia Metal Co. in the Southwestern territory, with headquarters at Dallas, Texas. These gentlemen have held prominent positions for years with representative concerns and are well qualified by experience and acquaintance to care for and upbuild the important interests entrusted to them in their respective territories.

EXCAVATING FOR THE NEW power house for the Northern Pacific Ry. Co., at Jamestown, N. D., has been commenced, the new structure to contain the power plants for operating the machinery, pumps, and supply light for the round house and yards. The power house will be fire-proof, built of brick, with gravel roof. Dimensions are 100 by 50 ft., one story of 25 ft. in height, with a pump pit 16 by 20 ft. The building, which is located just west of the round house, and at the east end of the stock yards, will have cement floors. It will contain the big boilers, electric dynamos for light and power pumps, and heating plant. A new galvanized iron smoke stack 3 ft. in diameter and 75 ft. high will be erected. The power house will be turned over to the railroad company about January 1, 1913.

THE MEETING OF THE TROY GAS Co., at Troy, N. Y., wherein it was decided to set aside money, said on reliable authority to be $100,000, though no public statement of the exact amount was given out, for the erection of a power plant for the generation of electrical energy, was one of the most interesting meetings held by that corporation in some time. The seriousness of the situation, and the great interest felt by the people, aroused by the action of Mayor Burns in taking the first steps to unite all vicinity communities in a battle for the people's rights, was shown by the presence of Anthony N. Brady of Albany. It is only most important sessions of this corporation that Mr. Brady bestirs himself to attend, although it is known that he is one of the heaviest stockholders in this and allied interests in Albany, New York, and Paris, France.

WORK HAS BEGUN on the erection of 2 new factories for Champaign, Ill., the structural steel and foundry factory of the Burr Co. and the new building for the Textile Co. The foundation is being laid for the Burr factory and workmen are cleaning up the debris of the old building for the new structure of the Textile Co. It is expected that the textile factory will be re-built by the first of the year. Until it is completed the textile people will have temporary quarters in the building formerly occupied by the Butchers' Supply & Refrigerator Co. The new structure will be a great deal like the old and will cost approximately the same amount of money.

The Burr building is to be a one-story structure of brick and steel. Its completion depends upon the price of steel. A low price on steel will mean the rushing of the building supplies, a high price will mean the postponement of the work. When completed, it will be a building 120 by 268 ft. The site is that of the old cordage factory in the northern part of the city. The foundation will probably be completed this week. The foundry department of the present Burr plant on Hickory street will be moved to the new place and the manufacture of structural steel added to the work of the company.

AMONG THE MANY IMPROVEMENTS in the Salmon Bay, Wash., factory district, where great progress is being made, the plant of the Pacific Coast Match Co. stands out prominently as the largest private undertaking of the year. The plant will be ready for operation about Jan. 1. The main building is of reinforced concrete, Class A type, containing no wood, and covers an area of 100 by 185 ft. It will consist of 2 full stories and a basement. The factory machinery will be operated by electricity with separate motors for each machine, and about 200 operatives will be employed. The monthly payroll will be about $9000. Every effort will be exerted to make the plant one of the most completely fireproof and sanitary in the city. In addition to the main building, there will be an annex for housing the boilers, engines, veneer mill and steam heating plant. A fireproof building for laboratory work, the mixing of chemicals and the storing of chemical supplies also will be separate from the main structure.

The factory, which will be the largest of the kind west of the Missouri River, will be served by the Oregon-Washington and Great Northern railroads and has a 200-ft. frontage on the Lake Washington Canal, adjoining the government dock at Twenty-seventh Avenue West. The site is one of the best in the city so far as transportation facilities and accessibility are concerned. The plant will have a capacity of about 2 carloads of matches a day and will be equipped with the Parker process machinery, using alder, spruce and other cheap soft woods, while the older forms of machinery in use in Eastern factories require the exclusive use of white pine, an expensive wood. The new machinery will also effect a considerable saving in labor. The buildings are being constructed by the Franklin Engineering Co., one of the best known construction companies in the Northwest.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

S-C WATER LEVEL REGULATOR

Device for Automatically Controlling Water Level in Boilers

REGULATORS known as type S-C, manufactured by the "S-C" Regulator Co., Fostoria, O., consist of 3 separate parts; the column connection, which always contains the boiler pressure; the generator and diapragm, which contain the induced pressure; the controlling valve, through which water is supplied to the boiler.

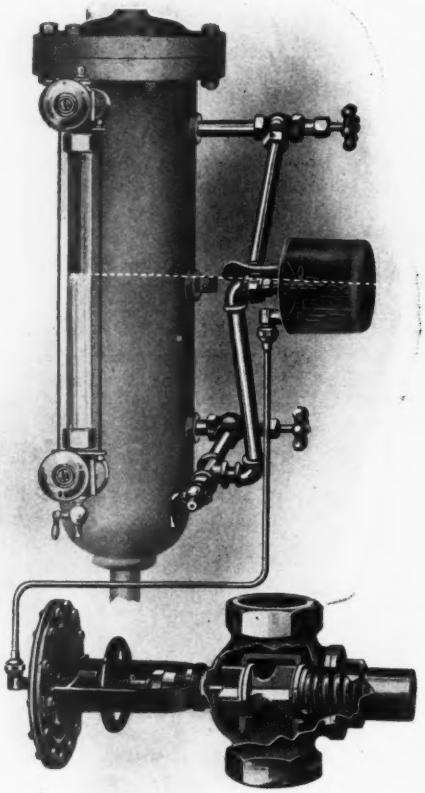


FIG. 1. METHOD OF ATTACHING TO ORDINARY WATER COLUMN

The first part, the column connection, is made up of ⅜-in. heavy seamless brass pipe and extra heavy fittings and is so constructed that one end attaches to the water column or boiler above the water line and the other end attaches below the water line of the boiler. This column connection acts like a gage glass, viz., the water will be the same height in the connection as it is in the boiler, the water column and the gage glass. Near the center of this connection is a bend placed in a horizontal plane. This bend or U-tube is located at the level where it is desired to carry the water level in the boiler.

Between the U-tube and the lower connection is a depression in the fittings which serves as a cooling chamber to break the circulation between the column and the U-tube.

It will be observed that by this arrangement the U-tube will always contain water or steam, depending on the height of the water in the boiler. If water is in the loop, the temperature of the loop is below

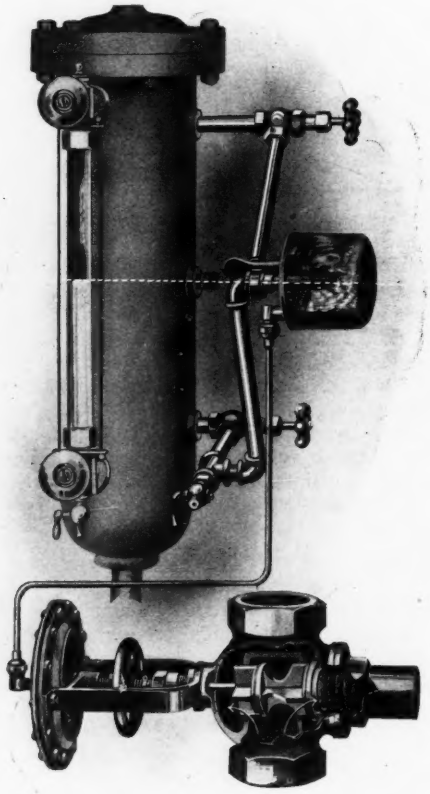


FIG. 2. SHOWING THE GENERATOR ATTACHED TO A WATER COLUMN WHEN WATER LEVEL IS LOW

the boiling point at one atmosphere. If steam is in the loop, its temperature is raised to approximately the temperature of the steam in the boiler.

This varying temperature of the U-loop is where the "S-C" Regulator derives its power to operate, not automatically but mechanically, as it is wholly dependent for its operation upon the height of the water in the boiler, with relation to the U-loop.

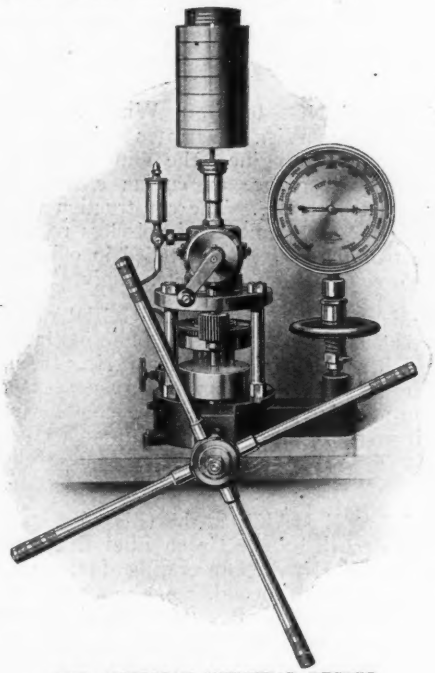
Referring to the illustrations, Fig. 1 shows the position of the valve and diaphragm when the water in the boiler is up. Note that the valve is closed, the diaphragm has discharged its water back into the generator and water fills the loop at the dotted line.

Figure 2 shows the water in the boiler down below the proper level. Water has run out of the loop and steam has entered, heating the loop. The steam forming in the generator is forcing the water into the diaphragm which opens the valve against the spring, supplying water to the boiler.

AMERICAN MULTIPAR HYDRAULIC DEAD WEIGHT TESTER

TESTING of gages for very high pressures has always been a difficult problem because of the large weights needed in a dead weight tester, and the joints in hydraulic testers.

After much experimenting, the American Steam Gauge and Valve Mfg. Co. of Boston, Mass., has developed a Hydraulic Dead Weight Tester in which a 10-oz. weight calibrates from 1 lb. to 100 lb. pressure and a 6.25-lb. weight from 100 lb. to 1000 lb. per sq. in. and other weight in proportion, the range running up to 25,000 lb. per sq. in.



THE AMERICAN MULTIPAR TESTER

The American Multipar tester consists of 3 cylinders, 3 pistons and 2 pressure chambers,—upper and lower. One ounce weight on the top piston gives 1 lb. pressure per square inch in the upper chamber, and this is exerted on a piston of 1 sq. in. area which is fitted into the lower part of the chamber.

This piston acts on one of smaller area, fitted into the lower chamber, so that the pressure transmitted to the lower chamber is larger than that in the upper by the ratio of the areas of pistons. This larger pressure acts directly on the gage to be tested.

In operation, weights are applied to the upper piston and the multiplying effect acts at once to give the pressure on the gage. For low pressures, a bypass between pressure chambers is opened allowing the pressure in the upper chamber to act direct on the gage.

Two weight pistons are supplied, the larger for pressures in the upper chamber of 1 to 100 lb., and the smaller for pressures of 10 lb. to 25,000 lb. The pressure screw in the lower chamber, operated by the handles, is used to take up compression of the liquid and maintain pressure in the lower chamber.

CATALOG NOTES

THE COUNTER-CURRENT or multi-stage principle in steam generation, towards the adoption of which there appears to be a tendency in recent practice, is discussed in a pamphlet, entitled "The Best Proportions of Boiler and Economizer Surface," issued by the Green Fuel Economizer Co., of Matteawan, N. Y. The proper limits of boiler and economizer surface are shown to be a boiler of 4 to 6 sq. ft. per boiler horsepower, discharging gases at 600 to 700 deg. F. to an economizer in which they are cooled to 300 deg. F. or lower, depending upon whether or not mechanical draft is used. It is pointed out that the economizer transfers 2 or 3 times as much heat as could the same amount of additional boiler surface at the same point in the travel of the gases, because of the greater temperature head available between the hot gases and feed water as compared with that between gases and steam.

THE VELOCITY STAGE TYPE of DeLaval steam turbines is described in a 48-page booklet recently issued by the DeLaval Steam Turbine Co., of Trenton, N. J. This is a velocity stage turbine with a single pressure stage, built in sizes up to 600 hp., suitable for direct connection to centrifugal pumps and blowers and small A.C. and D.C. generators, etc. This form of turbine is built for all steam conditions, i. e., receiving high pressure steam and exhausting to condenser or atmosphere or against back pressure, or operating on low pressure steam, either alone or with mixed flow. Copies of the book will be sent gratis to those interested in steam power plant equipment.

MODERN WELDED PIPE, published by the National Tube Co., of Pittsburgh presents in instructive form, with the aid of attractive illustrations, the processes from ore to finished product. Steel and wrought-iron pipe are compared as to physical properties, corrosion and cost; statistics summarize the results of tests determining the relative loss of weight by corrosion.

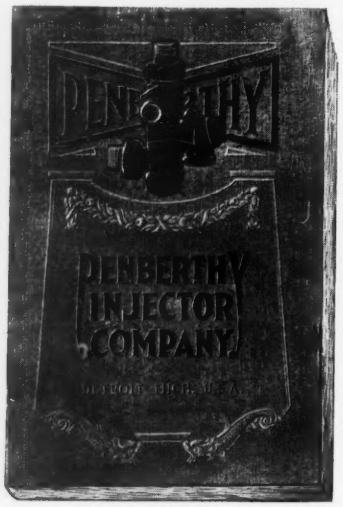
WATER TUBE, MARINE and standard boilers are shown and discussed in an 80-page catalog, No. B-3, from the Casey-Hedges Co., Chattanooga, Tenn. Features emphasized are: double inclination of the tubes, with reference to circulation; steel construction; arrangement with regard to cleaning and inspection; method of supporting; I beam and column suspension. Lap joint and butt joint types of riveting are compared as to construction and strength. Plans are given for house-heating firebox boilers.

AIR COMPRESSORS, Classes "A" and "B," built by Nagle Corliss Engine Works, Erie, Pa., will interest users of air compressors in capacities from 25 to 5000 cu. ft. of air a minute, 1 or 2-stage, belt, steam or electric drive. A table of sizes and capacities is given for each class, in Catalog No. 15, which illustrates the air compressors.

THE GENERAL ELECTRIC COMPANY has just issued a bulletin which illustrates and describes its Resistance Units for various motor-starting and speed-controlling rheostats. The number of the bulletin is 4973.

IN A FOLDER ENTITLED "3 Things to Increase the Efficiency of Your Refrigerating Plant," the Armstrong Cork Co., of Pittsburgh, gives some interesting facts in reference to Nonpareil insulating materials.

THE PENBERTHY INJECTOR CO. is sending out an 80-page book, and every superintendent and engineer at all interested in engine and boiler room practice should have a copy. It is complete with illustrations of injectors, ejectors, regrinding valves, safeguard water gages, etc. It thoroughly describes them, gives many facts to be considered in the select-



ing and handling of injectors, methods of connecting, information regarding repairs, tables of capacities, and a great deal of information that will come in handy to any engineer; the Penberthy Injector Co. of Detroit, Mich., offers to send it free of charge to those who care to write for it, mentioning Department "M."

THE THOMAS METER, as a large consumer's meter on the consumer's premises, is discussed in a pamphlet from the Cutler-Hammer Mfg. Co., of Milwaukee. This use of the meter is exemplified in a gas engine pumping station recently installed in connection with the sewage and drainage system of East St. Louis, which is described and illustrated.

THE THOMSON ELECTRIC WELDING Co. has published a 72-page catalog on electric welding machines. The bearing of the Thomson Process on the cost of current is indicated and the operations in which it is employed are named. The catalog illustrates many models of welders and gives a suggestive list of applications of electric welding.

CATALOG NO. 37, descriptive of Roto air, steam and water-driven tube cleaners for steam boilers, condensers, evaporators, etc., has lately been issued by the Roto Co., of Hartford, Conn. It contains a review of the progress and success of the tube cleaners during the past year, with a representative list of those using them. Among characteristics shown are light, seamless tubing for strength and hardened steel armor rings for wear.

THE SOLUTION OF LUBRICATION, a 12-page booklet from the Lindholm Metal Stamping Co., Camden, N. J., describes 6 varieties of drawn metal grease cups, giving exterior and sectional views.

CONSERVATION OF STEAM is the purpose of a scientific invention described in a circular concerning the Richards steam trap, telling what this invention does and does not do. The manufacturers are the Automatic Steam Trap Co., New Haven, Conn.

FACTS CONCERNING THE OPERATION of Taylor stokers are presented in 47 pages, giving results obtained from the use of Taylor stokers by various companies. The catalog containing the results of these tests is sent out by the American Engineering Co., of Philadelphia.

DURABLA SHEET PACKING for railroads and power houses, made by the Durabla Mfg. Co., of New York, is the subject of a pamphlet issued by the company, which guarantees Durabla asbestos packing for highest pressures, superheat, changes of temperature, heavy vibration, wet steam, hot water and hot oil.

BETSON PLASTIC FIRE BRICK CO., of Rome, N. Y., has issued a new illustrated pamphlet describing one-piece boiler furnace linings. This treats the subject fully, and contains interesting illustrations of how to do it. A copy may be had by writing to the company.

CATALOG NO. 40, from Wm. Bayley & Sons Co., Milwaukee, Wis., illustrates different types of Bayley automatic engines, the aim of the manufacturers being to produce an engine exactly fitted for direct-connected service. The construction is described as meeting the requirements of noiseless regulation. A partial list of those already installed in office buildings, central power plants, factories, etc., is given.

ICE-MAKING AND REFRIGERATING machinery is the subject of several bulletins lately issued by the Vilter Mfg. Co. Bulletin No. 15 shows oil traps, liquid receivers, ammonia condensers, etc., which, in addition to the ammonia condenser, include the high pressure side. Vilter ammonia compressors are fully described and illustrated in Bulletins 10 and 16.

WHAT WE MAKE is the title of a compact 48-page book issued by the Green Fuel Economizer Co., of Matteawan, N. Y., describing fuel economizers, both standard and special, coverings for fuel economizers, mechanical draft outfits, heating, ventilating and drying outfits, hot blast heaters, steel plate fans, motor and engine driven fans, cast-iron volume blowers, slow speed and standard speed planing mill exhausters, fan and cone wheels, wool wheels, ventilator wheels, propeller fans, vertical and horizontal engines and mechanical draft dampers.

NAPOLEON AND JEFFERSON are names known to everyone and stand for great accomplishment. They always attract attention and hold interest because they stand for achievment. And the pamphlets issued by the Jefferson Union Co. of Lexington, Mass., giving striking facts about these historic characters as Makers of Unions are worthy of reading and consideration. Interesting facts about Jefferson Unions and their achivements are also embodied in these pamphlets which can be had for a postal request to the company.

Sparks From The Advertising Pages

A foreign statesman who was noted as much for his shrewdness in business affairs as for his political wisdom, once said that the feature which marks off the successful from the unsuccessful man in any line of work is "intellectual" interest. Not "money" interest first, but interest in one's work simply as work.

There's a valuable hint here for all of us in these days when eagerness to make money—more money—often leads people to overlook the very means by which money may be made. For it is clear that to concentrate narrowly on one's work, is a sure way to make that work ineffective. The worker who would be successful, must know his own work in relation to other work in the same field—must study his methods, his equipment, his tools in the light of what is being accomplished by others. He must be alive to progress in his chosen sphere of work. In a word, he must have "intellectual" interest.

This kind of interest may come from a strong natural bias toward some particular line of effort. But it may also be cultivated by any one who realizes its importance. For instance, the engineer who is in danger of falling into a rut—and so diminishing his earning capacity—should seize every opportunity to keep himself "posted" on engineering "news," improvements in machinery, new devices for increasing efficiency or lessening expense in a plant—anything and everything new that is good and helpful.

Good and helpful—that is the point. Now, there is probably no more direct road to what is really valuable among the output of new engineering suggestions, than the advertising pages of this magazine. Why? Simply because the advertisers, as sensible men, are not going to spend money in drawing the attention of the public to machinery and devices of doubtful utility.

"Fake stuff" is of course still advertised in some newspapers and magazines, though in immensely smaller volume year after year. But we can answer for it that the scores of advertisers who use "Practical Engineer" are too experienced, to say nothing of their being too honorable, to advertise even the least expensive specialty which has not solid utility behind it.

You see, then, that our advertising pages supply you with "sifted" news—news freed from every element of doubt or suspicion. Not only that, but it is news prepared for you with very great care, so that it may put you in possession of the essential facts as quickly as possible.

Whether, therefore, your aim in reading the advertising pages is to find and buy something that will help you in your work, or whether you are simply seeking to keep bright and keen that "intellectual" interest which is the basis of success, you will be well rewarded for the time spent in reading them.

But let it be noted that the best results from reading the advertising pages are derived from systematic, close, observant study of them. Don't skip and don't hurry. Skipping may leave unnoticed just the very suggestions that would spell progress for you. Hurrying may convey a wrong impression of the construction or practicability of the new machine or device.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By engineer of gas engines. Experienced in operating and repairing gasoline engines up to 100 horsepower. Age, 22 years. I. C. S. course. Exemplary habits. At present in charge of repairs and operation of 65 horsepower plant. Address Box 266, care of Practical Engineer, Chicago, Ill. 12-2-1

POSITION WANTED—BY ENERGETIC AND PROGRESSIVE young man of 24 as assistant in medium size modern steam-electric plant. 3 years' experience with large Corliss engines. I. C. S. graduate and Chicago City License. Address Box 263, care of Practical Engineer, Chicago, Ill. 12-1-2

POSITION WANTED—By young man as oiler or engineer's helper. Graduate of Engineering. Two years' experience with gas engines. Address J. B. Johnson, Engr., Laurel, So. Dak. 12-15-1

POSITION WANTED—MANAGERIAL position, with Gas Company. Can handle all ends. Mechanical and Clerical. Results guaranteed. Good references. Address Box 259, Practical Engineer, Chicago, Ill. 12-1-2

POSITION WANTED—AS ENGINEER or machinist anywhere in the south where climate is above freezing point. Can give best of references. Address Isaac B. Fairbanks. St. Louis, Mich. 12-1-2

WANTED POSITION—AS CHIEF ENGINEER by man with over 15 years' experience as Chief of large Refrigerating and electrical plant. Thoroughly competent to handle plant and men. Strictly sober. Best References and License. Address Box 261, care of Practical Engineer, Chicago, Ill. 12-1-2

POSITION WANTED—CHIEF ENGINEER wishing change, 20 years' experience with Corliss and automatic engines, direct and alternating current machinery. At present in charge of lighting, heating, refrigerating, and storage battery plant. Age, 39. Address Box 262, care of Practical Engineer, Chicago, Ill. 12-1-2

POSITION WANTED—By young married man as millwright. Not afraid of work. Strictly sober and steady. Have had experience wiring lights and motors. Will go anywhere, Northern States Preferred. Address V. G. Lomprey, 1[illegible] Jenkins St., Menominee, Mich. 12-1-2

Wanted

WANTED—Man of wide acquaintance among engineers to solicit subscriptions for Practical Engineer in Pittsburgh, Pa. A good opportunity for the right man. 12-15-1

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once. tf

Help Wanted

HELP WANTED—ENGINEER in each locality, by a little use of his knowledge, can secure free subscription to engineering magazines, free tools, etc., as premiums. We also want agents. This interests you? "All right, write right now." Baker Valve Co., 1855 E. 28th St., Minneapolis, Minn. 12-1-2

WANTED—SALESMEN TO HANDLE as side line the best lubricating grease ever put on the market. Liberal commission. Address Box 264, care of Practical Engineer, Chicago, Ill. 12-1-2

WANTED—An additional subscription solicitor wanted to cover towns in state of Washington. Excellent chance to earn extra money. Write to Subscription Department. 12-15-1

For Sale

FOR SALE—12 and 20x10½x12 Epping Carpenter, compound duplex pump. Can be used single ¾ million gallons per day; pressures up to 200 lb., perfect condition, $500. Duzets & Son, 50 Church St., New York.

Patents and Patent Attorneys

PATENT APPLICATIONS—prepared and prosecuted for $25. Send for booklet. Harry Patton, 330 McGill Bldg., Washington, D. C.

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson & Son, Patent Solicitors, 710 G. St., Washington, D. C. 12-15-1

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owen Bldg., Washington, D. C. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request, 186 McGill Building, Washington, D. C. tf

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges, bound in leather. tf

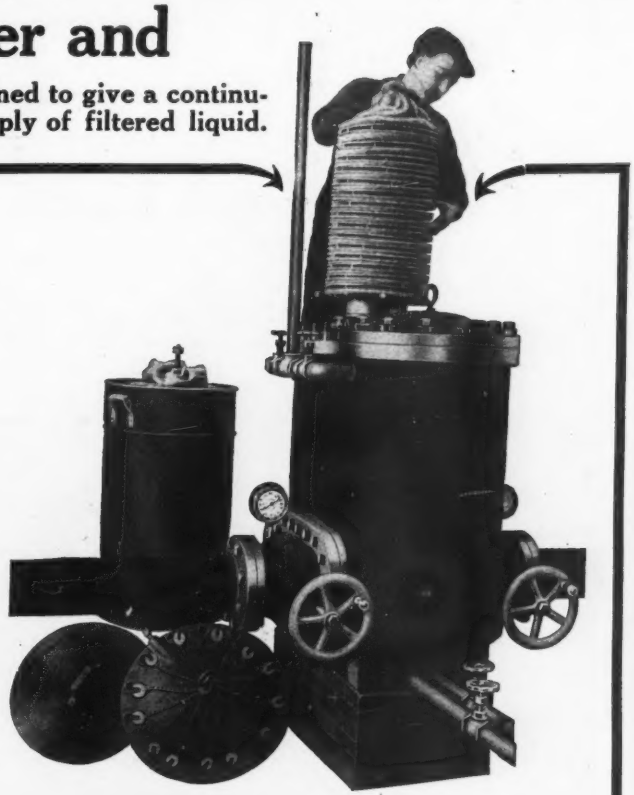
Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash-Yourker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf

The Elliott Twin Filter and Grease Extractor

is designed to give a continuous supply of filtered liquid.



Do you have

Oil and grease in your boiler feed water?
Sand or sediment in your service water?
Dirt or a heavy base in your fuel oils?
If you do, you should learn about the

TWIN

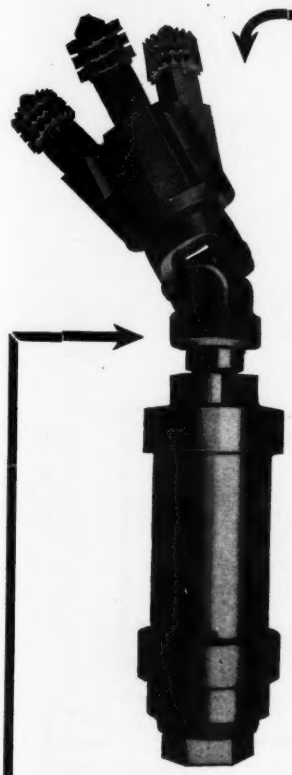
Points to Remember:

Two filtering chambers—Constant flow. Liquid filtered through one chamber while the other is being cleaned—Either chamber can be cut out of the line by simply shifting two gate valves—In cases of emergency or sudden demands both chambers can be put in service.

Write today for our bulletin on the **TWIN**, for it is the **only** filter on the market that gives uninterrupted service.

Elliott Company

6409 Susquehanna Street Pittsburgh, Pa.



Cyclone For Bent Tubes

Liberty Boiler Tube Cleaners

are the best possible insurance against boiler room accidents

Even a light coating of scale on the tube prevents the water from coming in contact with the metal, and the intense heat to which boiler tubes are subjected burns out the metal and an explosion is liable to happen, which frequently results in the loss of life.

Liberty Cleaners

are not only a safeguard against accidents of this nature, but are a **remunerative investment.** They will save in fuel their purchase price every month.

If you have been experimenting with other types of cleaners which have failed to make good, do not put the Liberty in the same class but let us send you one on trial, to prove their superiority and show you what a **real Cleaner** can do.

Write for Catalog.

Liberty Manufacturing Company

6904 Susquehanna Street

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THE SHEET PACKING OF THE HOUR

– IS –

Indestructible White Sheet

DOES THE WORK AT ALL TIMES

AND UNDER ALL CONDITIONS

STEAM, OILS AND AMMONIA COST MONEY why take chances in using a sheet packing which may do the work? There is no question about Indestructible White Sheet. It gives perfect satisfaction on high and low steam pressures, hot and cold water, ammonia, oils, greases and acids of all kinds. Eliminate your sheet packing troubles by sending in your trial order today for Indestructible White Sheet.

Have you a copy of our Packing Catalogue? If not, write, it is free.

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ENGINEERS AT REMOTE PLACES ALL OVER THE GLOBE DEMAND THE PACKING THAT HAS PROVEN ITSELF TO BE THE "BEST BY TEST"

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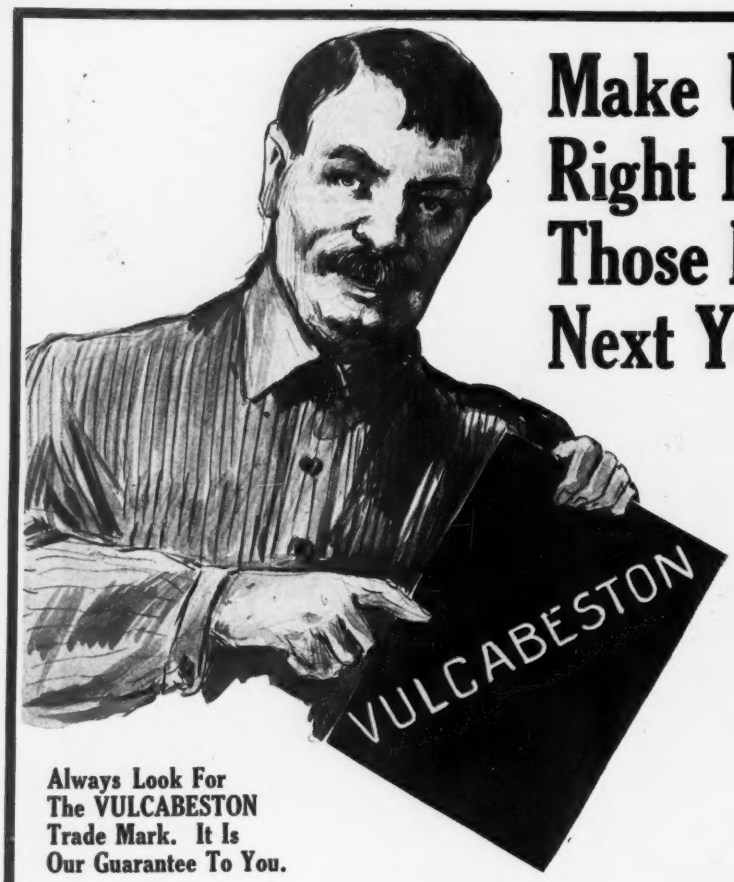

Always Look For The VULCABESTON Trade Mark. It Is Our Guarantee To You.

Make Up Your Mind, Right Now, To Cut Out Those Packing Troubles Next Year

Make up your mind to "shake" the night work, the Sunday work and the holiday work and get better packing results than you ever had before.

Then put it up to us to show you how to do it and we ***will*** show you.

Not because we know your business any better than you do, or half so well, but because we know Vulcabeston and what it will do, and are not afraid to spend the money to send out

Big, Generous Testing Samples Of VULCABESTON Packing Free

to prove every claim we make. Vulcabeston is 90% (nine-tenths) Pure Asbestos—Long Fibred Asbestos—the *lasting* kind. The other tenth part of Vulcabeston is made up of Rubber, for a bond, and Graphite, as a lubricant.

We use no Cotton, no short-fibred asbestos, no cheap filling material of any kind. Vulcabeston is just as nearly *all* Asbestos as a packing can be and hold together. Some call it "The Asbestos Packing That's Made of *Asbestos*."

But never mind what anybody else calls it, you *get* a Free Testing Sample, *try it out* and see what *you* call it—you, a practical man who knows packings and their shortcomings.

It won't take you long to see that it *is* a better packing and *why* it is better, because you can apply the tests that search the very soul of a packing for weak spots—faults. Will you *do* that? Will you do it *now*—for your own comfort and peace of mind—for the *daily* profit of your company?

Many Engineers prefer our Asbestos Rope Gaskets to any others—ask for a sample and see why. These Vulcabeston Rope Gaskets are ***more*** than 90% Asbestos—only the very best of Asbestos—the Long Fibred kind—***can*** be used in them.

Fill In The Coupon Below And Get It Right Into The Mail.

THE JOHNS-PRATT COMPANY, 553 CAPITOL AVE., HARTFORD, CONN.

H. W. JOHNS-MANVILLE COMPANY, - - - - - - - SELLING AGENTS

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Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Indianapolis, Kansas City, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, St. Louis, San Francisco, Seattle

For Canada:—THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED.
Toronto, Ont. Montreal, Que. Winnipeg, Man. Vancouver, B. C.

Coupon For Free Testing Sample of Vulcabeston

THE JOHNS-PRATT COMPANY, Hartford, Conn.

Gentlemen:—Please send to me at once, prepaid, a Generous Testing Sample of Vulcabeston Packing. Send me the kind of Vulcabeston that is best for service under the following conditions: (Tell us exactly the trouble you are having—where you want to try Vulcabeston. If you can't get it in the margin below, send a letter, attaching this coupon.)

Name..... Address.....

Position..... Company.....

IT is a well established fact that Keystone Grease will give greater efficiency with less friction than any other lubricant.

Eventually you will see the wisdom of using this perfect lubricant.

It will pay you to begin now.

One pound of Keystone Grease is guaranteed to equal in efficiency 3 to 4 pounds of any other grease on the market, or 4 to 6 gallons of the best bearing oil.

Keystone Lubricating Co.

Established 1884 PHILADELPHIA

Branch Offices and Warehouses in the Principal Cities of the United States. Agencies in the Principal Countries Throughout the World.

THIS IS THE COMPLETE OUTFIT

The Trained Engineer is The One Who Has the Big Job

The indicator did more toward training him for the BIG JOB than anything else—It's first use plainly showed the great store of knowledge to be gained of steam from the coal pile to smoke stack. It opened up the high road to the big job he is filling.

Robertson - Thompson Outfit

has lifted hundreds of engineers out of a rut, into positions of prominence. It's for you to say whether you will follow in their footsteps—the route is a pleasant and easy one coached by our plain, comprehensive book of instruction. The price of the outfit based on from manufacturer to user—no middle profit. Let us tell you more along these lines.

JAS. L. ROBERTSON & SONS

74-76 MURRAY STREET, NEW YORK

The Outside of the Inside

Is no proof of the material and workmanship. Take for instance

Genuine Eureka Packing

Looks don't enter into its make up. It's the superior material—rubber core—flax and lubricant and the manner in which they are combined on the inside that gives Eureka the reputation it has enjoyed for over 30 years.

THE IMITATOR

puts all of his efforts on the outside—his strong talking point being, "finer looking than Eureka" but the inside is a different proposition—just—very poor rubber—and the cheapest sort of lubricant. For those reasons he can sell it at a lower price to the dealer—who in turn charges about Eureka price—and the consumer gets "Stung." To our friends we beg that when ordering Eureka—not to accept a substitute. They will be doing justice to themselves and ourselves.

We make 30 other kinds for every device. Our catalog shows them want one?

EUREKA PACKING CO., 74-76 Murray St., New York

Corrugated Steel

Asbestos Covering

GOETZE DEVO GASKETS

Are the latest product of the Goetze Shops and the last word in metallic gasket making up to this writing.

Goetze Devo Gaskets are made expressly for the *extremes of pressure and temperature* found in modern practice—for service under *superheated* and *saturated steam* — for your *longest lines.*

The foundation of Goetze Devo Gaskets is of Steel—*Corrugated* Steel so strong and so full of "give and take" that there's no chance for expansion and contraction to make trouble.

This Corrugated Steel is Covered *Completely* with the Best Asbestos and this Best Asbestos, Coated Thoroughly with Pure Graphite, not only defies the highest of temperatures, but, being practically forced into the pores of the metal in the flanged surfaces of the piping by the "squeeze" and constant pressure of the steel corrugations beneath it, holds securely against the highest of pressures.

The Corrugated-Steel, Asbestos-Covered, Graphite-Coated Gasket, with a Five Year Guarantee. Every Genuine DEVO Gasket Bears a Red Label.

That's all there is to it. It's a simple thing, this Devo Gasket. But we're so *sure* of it—we know so well what it will do that we *Guarantee* it, and *authorize every Devo Dealer to Guarantee it for Five Years Continous Service in the Same Joint.*

The Gasket You Can Try For 90 Days at Our Risk. No Cure, No Pay. See List of DEVO Dealers Below.

Furthermore, we will supply you with Devo Gaskets (through the Devo Dealer in your town if there is one, otherwise direct) on 90 Days Trial At Our Risk. You are to *try* them—*to make them fail if you can*—and if you *do* make them fail *they shall not cost you one cent.*

You cannot have trouble and a Devo Gasket in the same joint at the same time. Enter Devo, Exit Trouble.

Try Devo Gaskets—peel them with your knife and see what they're made of—put them into your worst joints and see how they work. Find out for yourself the difference between metallic gaskets — why Devo Gaskets make permanently tight joints and almost never wear out. Do this with no risk to yourself by taking the matter up at once direct with us or with the Authorized Devo Dealer nearest you.

Leland Bros. Co., Los Angeles, Cal.
Leland & McKee Co., San Francisco, Cal.
General Fire Extinguisher Co., Atlanta, Ga.
Savannah Supply Co., Savannah, Ga.
Geo. B. Limbert & Co., Chicago, Ill.
B. F. Biggs Pump Co., Lafayette, Ind.
Globe Machinery & Supply Co., Des Moines, Ia.
Wichita Supply Co., Wichita, Kans.
E. D. Morton & Co., Louisville, Ky.
Robt. McMeiken & Son, Baltimore, Md.
G. B. Sherman & Co., Boston, Mass.
Russell Hardware Co., McAlester, Okla.
Schade Valve Mfg. Co., Philadelphia, Pa.
Empire Mine & Mill Supply Co., Pittsburgh, Pa.
Samuel Jackson Co., Pawtucket, R. I.
Carolina Supply Co., Greenville, S. C.
N. O. Nelson Co., Memphis, Tenn.

Goetze Gasket and Packing Company

Alert Pipe & Supply Co., Bay City, Mich.
Southern Railway Supply Co., St. Louis, Mo.
Simmons Pipe Bending Works, Newark, N. J.
W. L. Smith, Newburgh, N. Y.
H. H. W. Bergmann & Co., New York, N. Y.
N. L. Cramer, Oneida, N. Y.
Edward Joy Co., Syracuse, N. Y.
Salem Iron Works, Winston-Salem, N. C.
Merkel Bros. Co., Cincinnati, Ohio.
Gauld Co., Portland, Ohio.
Shaw Kendall Engineering Co., Toledo, Ohio.
Atlas Machine Co., Nashville, Tenn.
J. B. Russ, Houston, Texas.
F. Chas. Shugart, Sweetwater, Texas.
Superior Supply Co., Bluefield, W. Va.
J. W. Peper, Madison, Wis.
B. Hoffmann Mfg. Co., Milwaukee, Wis.

17 Allen Avenue, New Brunswick, N. J.

Don't buy a different packing for each condition. It means a larger stock on your hands—trouble by experimenting with a different packing in an emergency when the kind you want has been used up.

J-M Permanite Sheet Packing

meets all conditions. It makes permanent, tight joints that require no following up.

Made of long, tough fibers of pure Asbestos, J-M Permanite is the one packing that gives the best results for all purposes—high or low pressure, superheated or saturated steam, ammonia, acids, alkalies and sugar solutions. For cylinder heads, steam chests, pipe flanges or wherever a joint is to be made. It meets conditions that no other packing can meet.

J-M Permanite withstands highest temperatures and greatest pressures, as severe tests have proven, and it lasts forever. And being lighter in weight than rubber or organic packings, it is the cheapest to buy.

Write nearest branch today for sample and booklet.

H. W. JOHNS-MANVILLE CO.

Manufacturers of Asbestos and Magnesia Products. **ASBESTOS** Asbestos Roofings, Packings, Electrical Supplies, Etc.

Albany, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Indianapolis, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis, Syracuse

For Canada—THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED 1540
Toronto, Montreal, Winnipeg, Vancouver

Self-Lubricating, Frictionless

In Cans 6, 12, 25 and 50 Lbs.

Highest Award World's Fair, St. Louis

"SAFETY" PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Guaranteed to stand steam temperature to 550 deg. Fahr. and hydraulic pressure to 5,000 lbs. per sq. inch. Packing furnished in bulk and in Thin Cotton Tubes, size 3-16 to 1½ in., 36 in. long, or in lengths to fit your stuffing boxes. Empty Cotton Tubing in assorted sizes **FREE OF CHARGE** with orders for packing in bulk form. The tubes are easily filled.

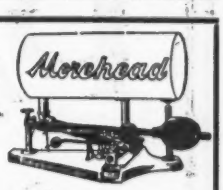
Any quantity sent on approval.

Send for **FREE SAMPLE.**

STEEL MILL PACKING CO., Detroit, Mich. U. S. A.

Morehead

Back to Boiler



SYSTEM

Feeds to your boilers water from your heater, from your water mains, or with condensation direct from your steam lines—a combined steam trap and boiler feed. Send for a trial trap and convince yourself at our expense.

Address Condensation Dept. **Morehead Mfg. Co.** Detroit, Mich.

MABBS

Trade-mark reg. U. S. Pat. Office.

THE PACKING THAT ACTS AS A LUBRICANT

Mabb's Rawhide Packing—strips of rawhide—is soft, pliable and antifrictional. Consequently, no danger of its cutting rod, plunger or cylinder. Lasts long and is easy to replace. Be sure to write for our descriptive circulars.

THE MABBS HYDRAULIC PACKING CO.
141 Jackson Boulevard CHICAGO, ILLINOIS

MABBS MABBS

RAWHIDE PACKING

See These Scraping Tools?

They've been called the "Engineer's Chum," they're so handy. For scraping Valves, Babbitt Metal, Journals, Bearings etc., they have no equal. Six scrapers in a set, sizes 8 to 14 inches, carefully forged, tempered and polished—ready for effective work. Each set packed in oak case.

COUPON.

Mound Tool & Scraper Co., 7th & Hickory Sts., St. Louis, Mo.

Gentlemen:

Enclosed find One ($1.00) Dollar for which send me one No. 2 set of Mound Hollow Ground Scraping Tools, price $3.50, and I hereby agree to remit the balance ($2.50) in three monthly payments.

Name ..... Date.....

City..... State.....

Diamond
Quality Service

Chief Wise says—

"ELBON IS A SURE CURE FOR A TROUBLESOME JOINT"

ELBON PACKING

For

Superheated Steam and High Pressures

You can settle many things for all time—but not so with packing. Power plant equipment has advanced with sensational strides during the last 5 or 10 years—and with it has come high pressures and superheated steam.

The packing that served you well a few years ago must give way to a better packing—and hundreds of engineers are turning to Elbon every month after facts and figures are put before them.

The use of "one packing" for all steam conditions can now be likened to the old family physician who prescribes for all ills. He will cure you in one place and utterly fail in another.

A roll of Elbon in your plant is the surest and cheapest way of freeing you from troublesome steam joints.

Elbon is not the only packing, but it is the best packing in existence today for superheated steam and high pressures—it can't burn and won't blow out—guaranteed to 400 pounds pressure.

SOLD BY DEALERS EVERYWHERE

Fill in and Mail Coupon

The Diamond Rubber Co. of N. Y.
Akron, O.
Subsidiary of The B. F. Goodrich Co.

The Diamond Rubber Co. of N. Y., Akron, O.
Please send me your book of helpful hints on packing—also a sample of Elbon, together with weights and prices.

Name .....

Address .....

.....

A NEW WRINKLE IN PISTON PACKING

Shortsville, N. Y., July 10th, 1912.

Magnolia Metal Co.,
113-115 Bank St.,
New York, N. Y.

Gentlemen:—

Your letter received some time ago regarding my experience with Magnolia Metal would have been answered before, but I was giving your metal a new test.

I have used it on crank pins, main bearing, guides of engines, also bearings on motors and high speed fans where other metals failed to hold. I had one 36-in. Fan that had to be rebabbitted nearly every day. After putting Magnolia in, it held over a year; held until the oiler neglected to keep plenty of oil in oilwell, which was no fault of the metal. It was on this Fan that I first learned of the value of Magnolia.

But the test I now wish to speak of is a Piston Packing for which I found that Magnolia proved a great success on a 180 H. P. Engine at 90 R. P. M. carrying load of 250 I. H. P. I could not keep any packing in stuffing box on piston that would hold over three or four days, so concluded to try Magnolia. Here is my method: I take the metal, place it in a milling machine, mill up fine, then prepare cloth sacks, fill with fine metal, wrap them around the piston, screw up gland and put engine to work. Piston will blow back two or three days and then stop and you will then have a perfect metallic Packing. I found that the pressure will drive metal together, which will wear for years. I have found that this never fails on bad rods where no packing will hold. I never tried this before on an overloaded Engine but on Engines carrying the rate of power but this engine that I have just treated is 180 H. P. Corliss, doing 250 I. H. P. and it proved O. K. as it always has before.

You may use this letter if you wish or I shall be pleased to aid anyone by my experience in using Magnolia, for I know its worth as I have used it in some hard places and always found it true to wear without trouble where other metals failed.

I always keep Magnolia on hand and would not be without it.

Yours very truly,
F. N. TITUS, Engineer,
Shortsville Wheel Works, Shortsville, N. Y.

SPECIAL OFFER

PRACTICAL ENGINEER POCKET BOOK—700 pages, over 2,000 subjects. Price, 40c postpaid. We import these books in large numbers, from England, as an advertising medium, and give Engineers benefit of low price. They are highly spoken of. Address, New York Office.

Sold By Leading Dealers Everywhere or By

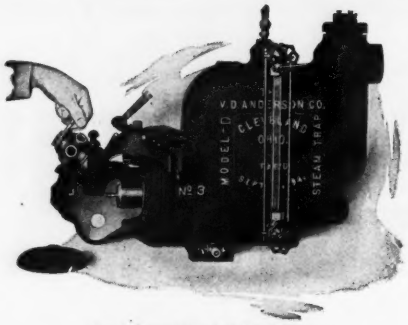
MAGNOLIA METAL CO.

NEW YORK 114 Bank St. | CHICAGO Fisher Bldg. | MONTREAL 225 St. Ambroise St.

The Anderson Model "D" Steam Trap Adaptable to Any Pressure in Less Than 5 Minutes

Change from exhaust to highest boiler pressure in less than 5 minutes and without breaking a steam joint or pipe connection—that is possible with this trap—a fact which is surely an important consideration. No special tools are required to remove the valve and seat—just a small rod and hooked wire.

And when Anderson Model "D" is at work, it works. You can bank on its yielding you the maximum of efficiency from every foot of heating surface. It maintains an even temperature because it drains continuously and steadily, disposing of the condensation as quickly as it accumulates. The gauge glass tells whether the trap is working properly.



Anderson Model "D" Trap
Removing the Valve Seat

The Factory Test is Thoroughgoing

The Anderson Model "D" Trap is tested in the factory under actual working conditions. It will do exactly what we say it will.

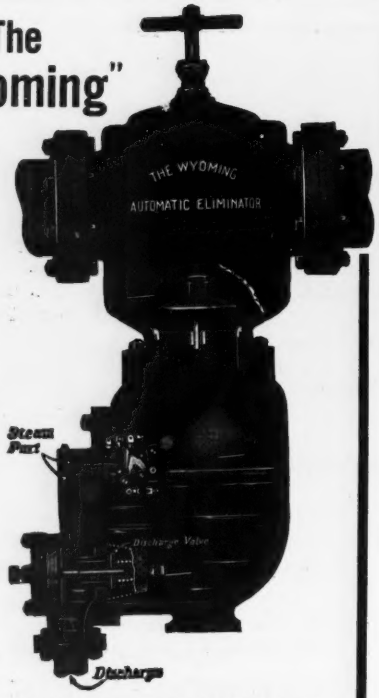
The Anderson Model "D" Trap is ideally simple in construction. The mere loosening of four bolts makes the interior accessible.

THE V. D. ANDERSON CO., 1937 West Ninety-Sixth St., Cleveland, Ohio

Stock carried by the following agents:

330 Manhattan Bldg.....Chicago
212 Walnut St.....Cincinnati
619 Park Bldg.....Pittsburgh
207 Union Trust Bldg...Baltimore
3 Arch St.....Philadelphia
91 High St.....Boston

The "Wyoming" Automatic Eliminator



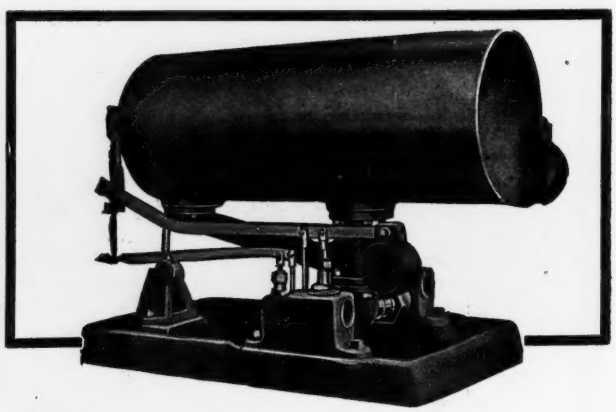
is your best protection against the accidents that arise from the presence of water in the cylinder. It copes sucessfully with every emergency—with "floods" and "slugs"—owing to the very large size of the piston-operated discharge valve.

The "Wyoming" is a steam trap as well as a separator. It discharges all moisture, condensation and impurities from the steam—effectually and without waste.

It is made in sizes from 2½ to 16 inches. Horizontal, Vertical and Angle Types—all guaranteed. Write for catalog.

W. H. NICHOLSON & COMPANY
WILKES-BARRE, - - PENNA.

AGENTS: Chas. N. Hays Co., Pittsburgh; Potter Separator Co., New York; D. T. Prenter & Co., Charleston, W. Va.; Fairbanks Company, Philadelphia, Syracuse



"Detroit" RETURN TRAPS

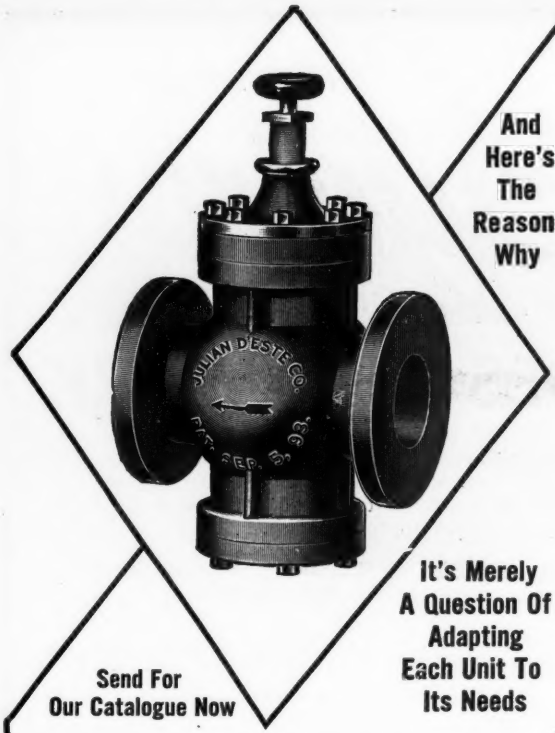
save the most valuable part of condensation—*its heat*

No wonder they save fuel

Bulletin No. 326-P describes the construction of "Detroit" Traps and tells you how to install them

AMERICAN BLOWER COMPANY
DETROIT, MICH.
U. S. A.

Canadian Sirocco Company, Limited., Windsor, Ont., Manufacturers for Canada



And Here's The Reason Why

It's Merely A Question Of Adapting Each Unit To Its Needs

Send For Our Catalogue Now

The Curtis

Improved Pressure Regulator Saves Money Wherever It Is Installed

You can use just the right amount of steam to operate economically and no more. It isn't necessary to use the high pressure maintained in your boiler for every device in your plant that uses steam.

That's waste—big waste, especially if you have, say a pump or an auxiliary machine that only requires half as much pressure as your engine.

Why not develop exactly what you need for each device. Compare the highest pressure needed in your plant with the lowest. Then think of the saving that a Curtis Pressure Regulator will accomplish in your own particular case.

You'll be interested in the many ways in which Curtis Specialties make for greater economy in the power plant.

JULIAN D'ESTE COMPANY
24 Canal St., Boston, Mass.
—AGENCIES—
216 Fulton Street, N. Y. City; 174 North Market Street, Chicago, Ill;
1233 Real Estate Trust Building, Philadelphia, Pa.

NEW BUNDY STEAM TRAPS

Can Be Purchased of the Following Sales Agents:

W. E. VanKeuren..... New York, N. Y.
J. G. O'Niel..... Chicago, Ill.
H. W. Reisinger..... Pittsburgh, Pa.
H. M. Fife.....St. Louis, Mo.
Coon-Devisser Co. ..... Detroit, Mich.
Root-Neal Co. ..... Buffalo, N. Y.
E. A. Sammons Co., Ltd.....New Orleans, La.
Reichman Crosby Co. .....Memphis, Tenn.
J. D. Caldwell..... Butte, Mont.
D. O. Morrill.....Spokane, Wash.

Gen. Fire Ex. Co., Atlanta, Ga. & N. Charlotte, N. C.
Sim D. Rollins & Co. .....Minneapolis, Minn.
H. R. Boynton & Co. .....Los Angeles, Cal.
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F. C. Stannard.....Salt Lake City, Utah
H. L. Peiler & Co.....Montreal & Toronto, Can.
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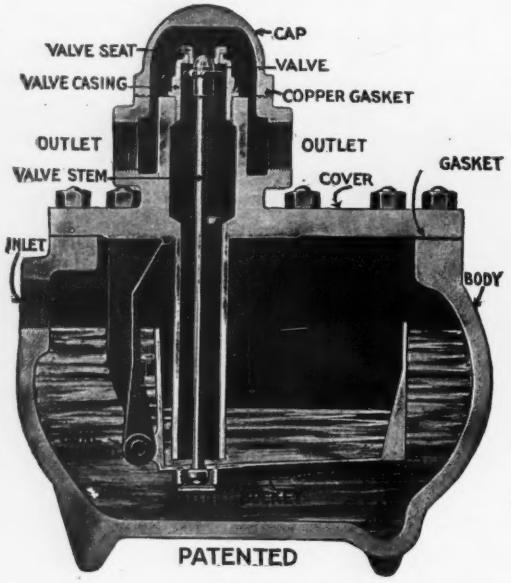
Simson, Balkwill Co. .....Vancouver, B. C.
H. Glyde Gregory.....San Juan, Porto Rico

Nashua Machine Co. Sales Office **127 Federal St., Boston, Mass.**



THE GENUINE

Squires STEAM TRAP

DOES THE WORK

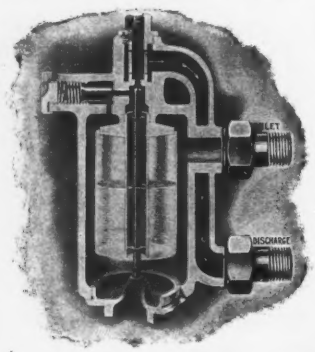
For high pressure power plants or low pressure heating systems or in any place where steam traps are used. Let us send you one or more subject to your approval.

WRITE FOR CATALOG E-9

THE C. E. SQUIRES COMPANY, East 40th St. & Kelley Ave., **CLEVELAND, OHIO**

PARTIAL LIST OF AGENTS.

Advance Packing & Supply Co...Chicago, Ill.
All Jobbers.....Cincinnati, O.
F. Boyle, 1135 Park Row Bldg., New York.
Buffalo Mill Supply Co.....Buffalo, N. Y.
Canada Foundry Co., Toronto, Ont., Can.
Engineering Spec. & Mach. Co...Omaha, Neb.
The Evans Mill Supply Co.....Boston, Mass.
All Jobbers.....Rochester, N. Y.
The Hendrie & Bolthoff Manufacturing & Supply Co.....Denver, Colo.
Indianapolis Belting & Supply Co., Indianapolis, Ind.
Kansas City Engineering Co..Kansas City, Mo.
Laib Company.....Louisville, Ky.
A. M. Lockett & Co.....New Orleans, La.
McCullam & Co.....Philadelphia, Pa.
W. E. Mushet Co.....San Francisco, Cal.
Pittsburgh Gage & Supply Co..Pittsburgh, Pa.
Robinson, Cary & Sands Co...St. Paul, Minn.
L. M. Rumsey Mfg. Co.....St. Louis, Mo.

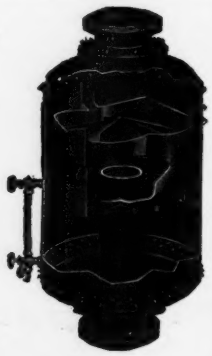


The Stickle Thermic Vacuum Valve

FOR VACUUM HEATING SERVICE

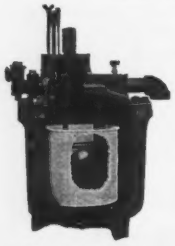
Our engineers make a specialty of industrial heating both direct and ventilating blast systems. We also superintend the installation of our system.

Stickle Horizontal and Vertical Triplex Steam Separators



Open Coil Heater & Purifier Co. 502 South Pennsylvania St. **Indianapolis, Ind.**

Learn All About the Direct Decendant of The Original Return Trap



Over 42 years ago we invented and built in our own shops the original return trap.

Our **Class "A" Return Trap** is its direct heir—improved to meet high pressure engineering requirements. Thousands are in use in every country where steam is used.

Albany Return Traps are sure to operate longest, without bother or repairs. Try one.

Write for Bulletin—Series E.

Albany Steam Trap Co., Albany N. Y.

The "P. B. H." Quick-Closing Water Gauge

is an accident insurance against scalds and burns. If the glass breaks, a pull of the chain shuts off both the steam and water. Its structure is perfect; extra heavy body, best steam metal, with extra large nuts for extra heavy washers. Less than a quarter turn of stem fully closes or opens valves.

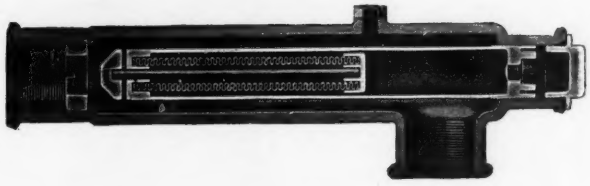
Sent on trial. *Write for Catalog.*

The Paul B. Huyette Company, Inc.

High Grade Steam Specialties

S. E. Cor. 18th & Market Sts., Suite 20, Philadelphia, Pa.

The Day You Install a "Sarco"—That Very Day You Begin to Save Money and Trouble



Sarco traps cost less because their construction is so simple—practically nothing more than the case and the cartridge. They save trouble because there's nothing complicated about them to get out of order—no levers; buckets, floats, stuffing boxes or packing—the very features that make so many traps expensive not only as regards first cost but in their upkeep.

"Sarco" Steam Traps Are Expansion Traps

They are actuated by the expansion of a liquid held in a hermetically sealed tube. This liquid is extremely sensitive to temperature and its expansion or contraction moves a valve which has a conical top.

This is the principle of "Sarco" operation in a nutshell—simple yet highly effective.

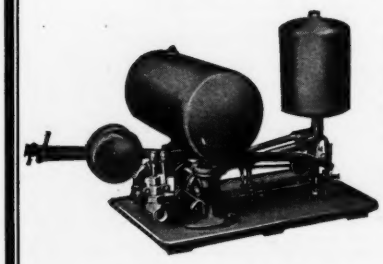
Among our regular customers are some of the biggest and best known power plants in America, one of which has given us 70 repeat orders. But why not find out for yourself just what a "Sarco" will do in your plant—we will gladly send a "Sarco" Trap to any responsible concern on trial.

Write now for complete information and prices.

SARCO ENGINEERING CO., 114 BROAD STREET, NEW YORK

A Few Territories Open to Energetic Sales Agents

The Chicago Return Steam Trap



SAVES MONEY IN THE COAL PILE

Every user of coal *yells* when he thinks the COAL BILLS are *too* high.

Save your condensation from coils, and return it to the boiler hot, and pure. Only one-tenth the steam is required to operate our trap over the best pump built.

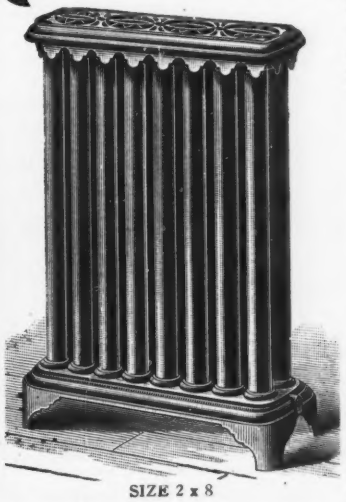
The Chicago & Northwestern Railway new Round house have just installed five, and they are well pleased. So would you if you ever were equipped with one of our traps. Get a trap that has no weight on large trunnions, and no monstrous levers and weights to act as a counterbalance. Metallic Packing is used. If your flow of water is sluggish use our Vacuum Trap.

Ask for our bulletin. Its yours for the asking.

THURTELL-HUGHSON COMPANY
22 Quincy Street - - CHICAGO, ILL.

NASON High Pressure RADIATORS

This surface is designed especially for high stream pressures, and for conditions where a comparatively indestructible radiator is required, for either high or low pressures. They are made in a standard 35 inch height in which each tube is the equivalent of a square foot of heating surface.



SIZE 2 x 8

By the way, Chief—our "VP" Specialty Catalogue will be found a handy Practical Little Vest Pocket Companion.

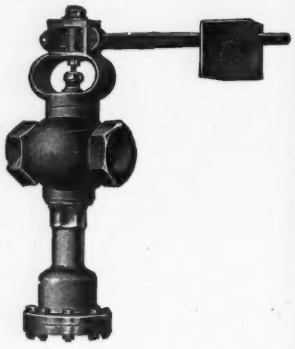
A post card brings it.

They can also be furnished in low heights to 9 inches, and will circulate perfectly as high as 5 feet. Regularly tested for 125 lbs. and made specially for working pressures to 250 lbs.

Nason Mfg. Co., 71 Fulton St., N. Y.
Specialty Specialists

The Fulton Differential Boiler-Feed Pump Governor

Maintains a **constant overpressure** in the feed line regardless of variation in boiler pressure. It automatically regulates the speed of the pump according to the requirements of the boilers.



It is simple, effective, easily understood and operated. There are no complex or delicate parts to wear out or get out of order.

All Fulton Governors are provided with **removable valve seats.**

The Fulton Defferential Boiler Feed Pump Governor is without exception the best governor on the market. **You** want it.

We also manufacture Tank or Altitude Governors and the **Vigilant Feed Water Regulator.**

Write for complete Catalog

THE CHAPLIN-FULTON MFG. CO., - Pittsburgh, Pa.

Represented by D. W. Patterson, Harrison Bldg., Philadelphia;
J. E. Gimperling & Son, Dayton, O.;
Lord & Ward, Chicago, Ill.;
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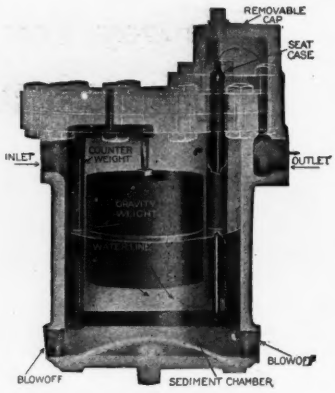
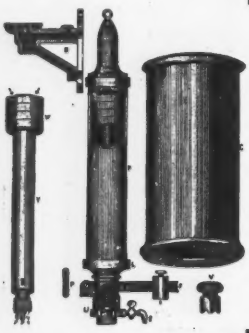
Simple and Strong and Safe



KITTS "T-C" STEAM TRAP

Simple in construction—just unbolt the cap and the valve and seat are exposed. Strongly built—insuring long service under the severest conditions. Safe—adaptable for operating at any pressure high or low. That is, in brief, the story of the Kitts trap. For details, get our Catalog; sent free on request.

KITTS MFG. COMPANY, Oswego, N. Y.



Why the Kellum Automatic Steam Damper Regulator Is So Accurate and Sensitive

Note the illustration.

The weight I (from 1¼ to 1½ pounds) is adjusted on the lever F so that the valve V will open at the pressure which you desire to carry at the boiler when the steam entering ports Q passes through the piston Y, raising the cylinder gradually until cap L comes in contact with the bottom of ground joint W, at which time the damper is entirely closed.

As the boiler pressure lowers valve V is pressed to its seat by weighted lever F and as the condensation passes from within the piston through the pet-cock E the cylinder descends drawing the damper open.

This operation is so sensitive that the lightest pocket 'kerchief thrown over the lever F will vary its movement up or down. The working is as sure and precise as machinery can possibly be made. Made entirely of metal—nothing to wear or get out of order.

Write for Interesting Descriptive Folder and List of References.

"This revokes all former price lists for Kellum Steam Damper Regulator." Send for new price lists.

Hess & Barker, Engineers and Machinists, 605 Sansom St., Philadelphia

Barton Steam Traps Are Scientific Economizers

They consist of an inner and an outer expansion tube. The outlet end of the inner tube bears the valve seat. When the steam enters the inner tube, it expands and seats itself against the valve disc, thereby sealing the trap. When condensation takes place, the inner tube contracts, allowing the water to escape.

The action is automatic, always water-sealed when steam is on the system and always open when steam is not in use, allowing all water to drain out.

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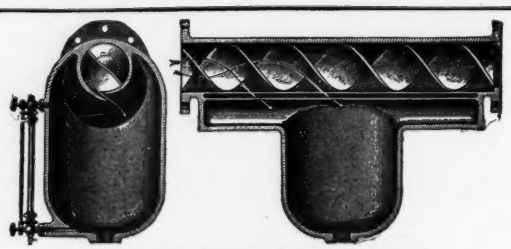
Automatic Steam Trap & Specialty Co.

West 2nd and Noble Ct. Cleveland, Ohio



STOP THAT KNOCK WITH A

SEPARATOR THAT REALLY SEPARATES

"The Whirl and the Edge does it"

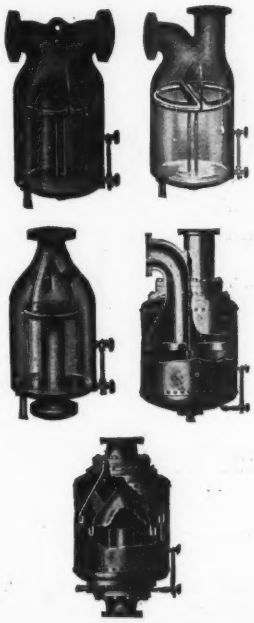
Catalog C of Separator information sent on request

Mosher Water Tube Boiler Co., 30 Church St., New York

No Loss in Pressure When Steam Passes Through a Hoppes Separator

There are no baffle plates or other arrangements to offer resistance to the steam.

That means absolutely no reduction in the initial pressure even after the process of separation is completed. The large bodies of these separators give ample receiving capacity for taking care of sudden flushes of water which may be carried over from the boiler, making them positive insurance against engine accidents. The smallest port in Hoppes Separators is three and one-half times the area of the pipe. The interior of the separator is made as smooth as possible. There are no edges from which the water of entrainment can be blown off and atomized.



Hoppes Separators are made in one casting and contain no detachable parts to get out of order. They are constructed for horizontal, vertical, or right angle service. All types operate essentially the same and will withstand a working pressure of 200 lbs. per square inch.

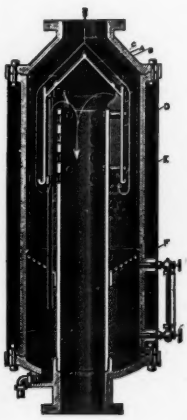
Our Separator catalog gives a complete description. An engineer's library is incomplete without it. It is free and will be sent promptly upon request.

We also Manufacture Feed Water Heaters, Oil Eliminators and Exhaust Heads

HOPPES MFG. COMPANY

70 Larch Street
Springfield, Ohio

Steam 99.8% Dry



You would be satisfied if you could deliver steam as dry as that to your engine; wouldn't you? That is the result attained under severe tests by

Sweet's Separators

Their ability to deliver thoroughly dry steam, day in and day out, is an important factor in operating efficiency.

Once Used, Always Wanted

More than half of the 7000 or so in use were repeat orders. Nothing could express more emphatically the merits of Sweet's Separators.

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820 Geddes Street Syracuse, N. Y.

It Pays To Install

COCHRANE SEPARATORS

Engines supplied with dry steam through a Cochrane Separator require from 30 to 50 per cent less cylinder oil, and at the same time run with less friction and wear.

Many large concerns are now adopting a policy of putting a Cochrane Separator ahead of every piece of steam-utilizing apparatus throughout the plant, including air compressors, pumps, small turbines, etc.

This has been found to pay in the steam saved, as compared with the former practice of leaving drip cocks open to discharge the water.

All the above benefits are in addition to the protection afforded to the engine and turbine.

Send for our booklet *"Celebrated Cochrane Lines." No. 16-S."*

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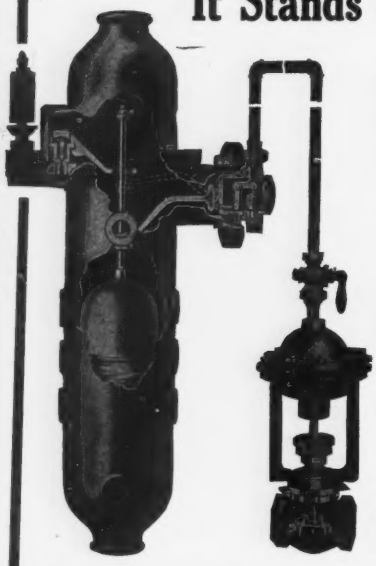
3144 N. 17th Street PHILADELPHIA, PA.

It Stands The Strain



The engineer who takes a pride in the economy as well as the efficiency of his plant, will find it advisable—for two weighty reasons—to specify

The Williams Safety Feed Water Regulator

Its positive, accurate regulation of your water supply, helps to cut down fuel consumption. And the fact that it is

Simple and Strong in Construction

enables it to stand the strain under the most severe conditions. Users of the Williams figure that it will last twice as long as the ordinary Regulator.

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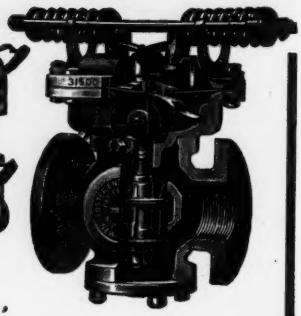
The Williams Gauge Co. 543-5-7 Fourth Ave. PITTSBURGH, PA.

Foster Valves



Class "W" Valve

"Reliability Their Main Feature"

Wide and diversified as the requirements are at the present time, there are certain Foster types to meet every need of the engineer.

Foster Valves are made for economy—some, in addition, assure safety—with them all there is one main feature which is **sure and dependable performance under varying conditions.**

You can bank on **Reliability** if you install a Foster Valve, whether high pressure regulator, low pressure regulator, back pressure regulator, blower valve, free exhaust valve, emergancy valve, class "U" pressure regulator, excess boiler feed pump governor, or automatic non-return stop valve.

Write for our new catalogue, which will soon be off the press.

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Newark, N. J.

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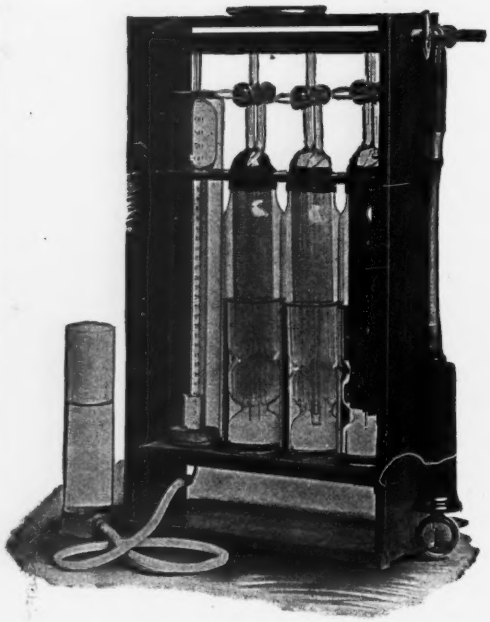

Simple and Easy to Operate. Practical Engineers and intelligent firemen have no trouble in learning to use it.

Learn What's Going On Inside Your Furnace

You cannot get the best possible combustion—uniformly maintained furnace efficiency—without an accurate analysis of the flue gas. Imagine yourself trying to get along without a steam gauge and recorder attached to your boiler! Yet the actual condition of the fires can only be guessed at without some means of detecting improper combustion. This is provided by

The Williams Improved Flue Gas Analysis Apparatus

When you know CO_2, you are firing scientifically—economically. The Williams Apparatus gives you the analysis in a few moments. It is a simple, easily manipulated and accurate device; compact, light and portable. Write for further particulars.

F. M. Williams, Watertown, N. Y.

Consulting Chemical Engineer and Industrial Chemist

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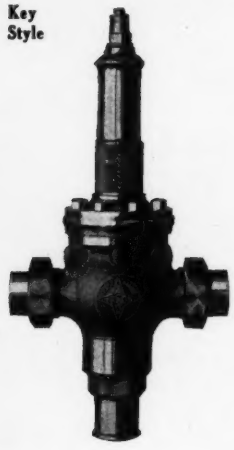
MASON REGULATORS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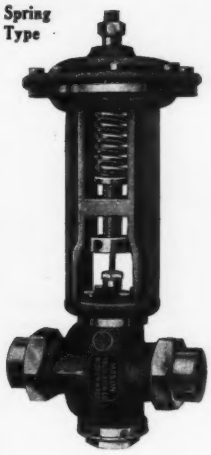
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Lever Type For Elevator Pumps

Mason Pump Regulators

are for the close, accurate regulation of pressure in Fire, Boiler-Feed, Elevator, Air and Water Works Pumps, having steam supply pipe 12 inches or smaller, or in any class of pumping machinery where it is necessary to maintain a constant pressure.

These Mason Pump Pressure Regulators, placed in the steam pipe supplying the pump and connected to the discharge system by ¼-inch pipe, accurately regulate the supply of steam to the requirements of the pump, automatically maintaining a uniform discharge pressure, regardless of any variation of steam pressure or demand on the pump.

Have you ever considered the extent to which Mason Devices for the Automatic, Accurate, Positive and Continuous Control and Regulation of Steam, Air or Water Pressure, can help *you* by *increasing* the *efficiency* of the plant in your charge while *reducing your labor?*

Isn't this a good time to give thought to these things that have an important bearing upon your own advancement during the coming year?

Mason Service is an Advisory, Engineering Service which assists you in determining where and which Mason Devices are most needed in your plant, and then helps you to correctly install them.

Write our Engineering Department to-day about the conditions in your plant. There is no charge for advice based on our third-of-a-century experience in the solution of all sorts of regulating problems, and we do not expect to do business with you until we have shown you how much it is to the advantage of your company and yourself—nor even then if you do not choose.

THIS 180-PAGE TEXT BOOK

Yours at Half-Price—25c just because it contains a dozen pages of Mason Valve talk at the back. It's a very handy, useful book—worth a dollar of any Engineer's money. Has a department on Electricity. Limp binding—pages 4x6½.

USE THIS COUPON TODAY

Mason Pump Regulators and Mason Reducing Valves of all types can be supplied by your dealer. Write us direct for all further details.

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Key to Steam Engineering

P.E. 12 15 12

Find enclosed 25 cents, for which send me postpaid copy of your handbook—"Key to Steam Engineering."

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NEW

DURABLA Valve Disc

For Severe Service

Durabla is a High Pressure Disc, unbreakable, unaffeted by Ammonia or oils, and makes a perfect seat.

Scientifically prepared, Durabla is made to give lasting service under *all conditions*. Look for the Trade Mark.

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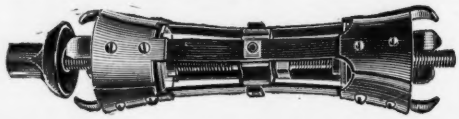
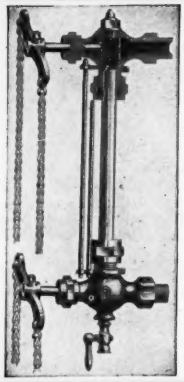
The "Scoop Motion" Tube Cleaner



The Fireman's Favorite" is a marked improvement on the once popular "Engineer's Favorite." The "Scoop Motion" and the steel arms with cutting edges effectually remove soot or scale from the tubes.

ORDER ONE NOW!

A. W. CHESTERTON CO.
64 India Street Boston, Mass.



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Water Gauge

Comes to you fitted with high grade steam packing—ready to use.
Chain operation protects user.
Ohio Water Gauges, Gauge Cocks and Regulating Valves can be obtained promptly from your dealer.

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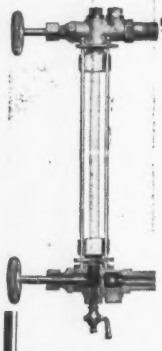
The Ohio Brass Co., Mansfield, O.



PROGRESS IS IRRESISTABLE!

Sixty years ago many boilers were without any water gage whatsoever. Since then the gage has become compulsory, and now the up to date boiler is equipped with the

Watertown Automatic Safety Water Gage

because it combines absolute protecion from breaking gage glass accidents with simple construction, ease of cleaning and inspection, and impossibility of being affected by hard or muddy water.

Send for Circular G-2 describing the gage in detail.

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—Our Standard— Steam Pipe Casing

For insulating underground steam pipes has stood the test for over 35 years.

Simple — Durable — Most Efficient

Write today for prices and Bulletin No. 114.

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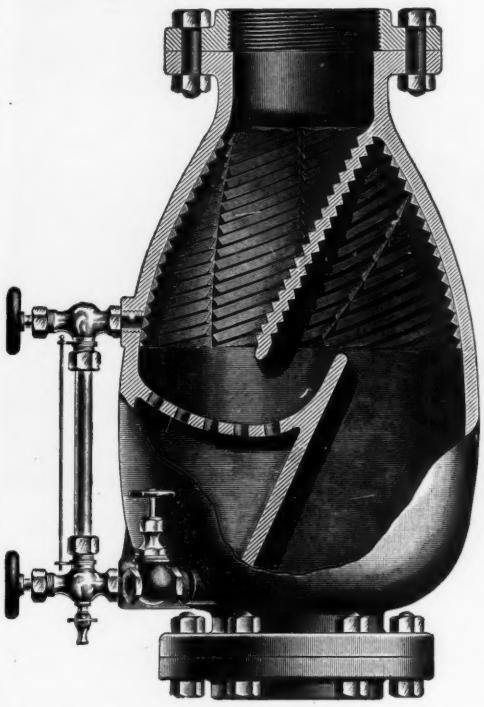

We ship on trial and pay the freight both ways on any "Austin" Separator that fails to satisfy.

WE WISH YOU ALL A MERRY CHRISTMAS, AND A GLAD NEW YEAR

AUSTIN FIGURE "A"

VERTICAL IRON

STEAM SEPARATORS

Have been rendering splendid service in delivering Dry Steam to engine cylinders in thousands of installations all over this country and in foreign lands *for more than seventeen years.* It is the ideal steam separator for plants in which ordinary, every-day conditions prevail. It is but one of many "Austin" types, some one of which will *exactly* suit *your* requirements.

SEND TODAY FOR CATALOG D-30
WRITE US

AUSTIN SEPARATOR COMPANY
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A Happy Christmas to You and a Glad New Year

Your Experience

has taught you the vital importance of **keeping the water in your boilers at the center gauge.** Our experience, and that of hundreds of engineers, has demonstrated that

"Murray" Automatic Boiler Feed Regulators

do keep the water in boilers at the center gauge—the High Efficiency Level. They do it automatically, dependably, economically—and their installation insures maximum generation of steam with minimum consumption of fuel. With "Murray" regulators installed, you can operate **your** plant at **higher efficiency**—and for **less money.** Are you willing to do that? Wouldn't you like to **get** more steam and **use** less coal? Sure you would. Then send for a couple of "Murrays" to try out in your boiler room at our risk. We'll pay freight going and coming if they don't make good.

Send Today for Illustrated Catalog "J."

MURRAY SPECIALTY M'F'G. COMPANY
DETROIT, 61 Woodbridge Street MICHIGAN

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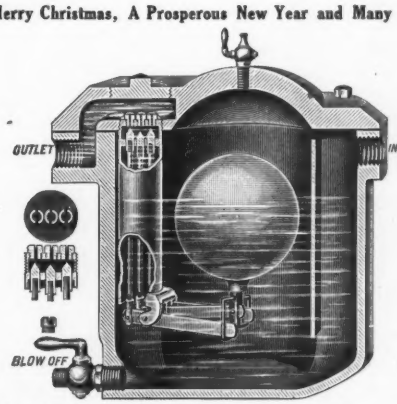
A Merry Christmas, A Prosperous New Year and Many of Them



It's absolutely impossible to waste steam through the operation of a

"WRIGHT" EMERGENCY

HIGH PRESSURE—CONTINUAL FLOW

STEAM TRAP

Three valves insure great capacity and keep the water drained regardless of small or large quantities.

Send for Catalog C-80 and remember, you can try one at our expense. We'll pay the freight both ways if a test fails to give satisfaction.

WRIGHT MANUFACTURING COMPANY
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And This

From a

BOILER

that

"We Had No Idea Was So Dirty"

Most engineers think their boilers are clean,—but **thinking** does not make them so.

The engineer in the above plant **thought** his boilers were clean. But the scale fooled him, and a **Weinland Tube Cleaner** with its efficient **Quick Repair Head** got six wheel barrows of scale out of a 150 HP. boiler. Here's what the Chief Engineer had to say about it:

Weinland Air Driven Tube Cleaner

"* * * * We had some of the caps off last winter but had no idea the boiler was so dirty.

"In regard to using the photograph, as long as you are not using any names it will be all right. You can refer to me at any time and I will be glad to verify these statements. I always have a good word for the Lagonda turbine. Hoping this may do not only you, but a great many engineers a great deal of good, I am,

Very truly yours,"

Weinland Water Driven Tube Cleaner

Mr. Blank's boss doesn't want his name used, but you might as well profit by his experience because he is an A1 engineer. Are you **"thinking"** your boilers clean? Why not stop dreaming and come down to brass tacks and see if they are so. Maybe you haven't got a wheel-barrow-full of scale for every 30 HP., but a shovel-full will do enough damage. Do you know that we have over 70 different boiler tube cleaners for all conditions? Ask us to send you a copy of Catalog PL and find out about these.

The Lagonda Mfg. Co.

SPRINGFIELD, OHIO.

FUEL SAVING SPECIALISTS

NEW YORK, BOSTON, PHILADELPHIA, PITTSBURG, CHICAGO, DETROIT, ST. LOUIS, SAN FRANCISCO, ST. PAUL, MONTREAL, LONDON

Makers of Weinland Boiler Tube Cleaners, Automatic Cut-Off Valves, Reseating Machines, Boiler Tube Cutters and Water Strainers

157

THERE IS A LIFETIME OF USEFULNESS IN THE

BURT EXHAUST HEADS

The materials used and their method of construction guarantees unusual durability. Made of extra heavy steel plate with malleable iron bases and drips. No baffle plates, diaphragm or scrap metal.

Their usefulness is as striking as their longevity. They prevent drenching and disfigurement of the building and rottening of the roof. They do not injure adjoining property. They prevent accidents resulting from the formation of ice on sidewalks due to the falling of condensed steam.

They help to keep the boilers clean, as they return the water freed from lime or other sediments, thus preventing the formation of scale.

The new Burt, 128-page catalog describes and illustrates fully Burt Oil Filters, Automatic Oiling Systems, Ventilators and Exhaust Heads. Write for it.

THE BURT MANUFACTURING CO.

204 Main Street, - - Akron, Ohio

Largest Manufacturers of Oil Filters in the World. Geo. W. Lord & Company, Montreal, Sole Manufacturers of "Burt" Ventilators in Canada

To All Readers of

American Quality Advertisements

WITH this number we have completed one of the most extensive and consistent campaigns ever undertaken by any manufacturer of Steam Gauges, Safety Valves, etc., in the world.

Regardless of temporary lulls in business, we have constantly persisted in fighting out on one issue only—viz.: Quality.

Our campaign has been appreciated.

We have made the best goods that could be made, and have educated our competitors to see that there is a better market for quality goods than they ever supposed.

There will always be price-slicers in our business; but, thanks to the inteligence of the majority of our readers, they no longed menace legitimate trade.

Temporarily we shall withdraw from these pages as we feel that our original plan has been carried out; therefore we take this opportunity to thank both the publishers and the readers of Practical Engineer for the hearty support and success they have given to American Quality Products.

We believe that our constant efforts to produce only the very best will continue to merit your increased business and confidence.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

Sales Offices in New York, Chicago, San Francisco, Pittsburgh, Atlanta, Montreal

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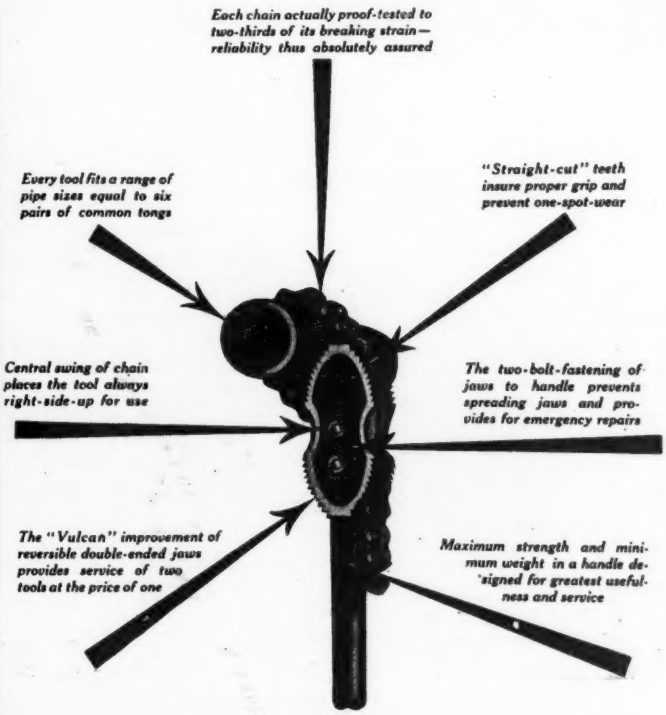
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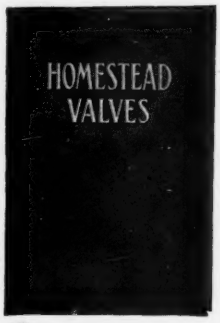

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Wright Mfg. Co., Detroit, Mich.

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Chesterton & Co., A. W., Boston, Mass. "Sonderglas."
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Lunkenheimer Co., The, Cincinnati, Ohio.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Rogers Co., H. A., New York, N. Y. "Moncrieff."
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "Robax and Durax."
Williams Valve Co., D. T., Cincinnati, Ohio.

GAUGE GLASS CUTTERS.
Chesterton & Co., A. W., Boston, Mass.

GAUGE TESTERS.
Ashton Valve Co., Boston, Mass.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa. "Pittsburgh."
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."

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American Engine Co., Bound Brook, N. J.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

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Chaplin Fulton Mfg. Co., Pittsburgh, Pa. "Fulton."
Davis Regulator Co., G. M., Chicago.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Foster Engineering Co., Newark.
Kitts Mfg. Co., Oswego, N. Y.
Mason Regulator Co., Boston, Mass.
Squires Co., The C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Williams Gauge Co., Pittsburgh, Pa.

GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J. "Ticonderoga."
United States Graphite Co., The, Saginaw, Mich.

GRAPHITE PRODUCTS.
United States Graphite Co., Saginaw, Mich.

GRAPHITED GREASE.
Dixon Crucible Co., Jos., Jersey City, N. J.
Swain Lubricator Co., Chicago, Ill.
United States Graphite Co., The, Saginaw, Mich.

GRATES.
Green Engineering Co., Chicago, Ill.
Kelly Foundry & Mach. Works, Goshen, Ind.
McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., The, Chicago, Ill.
Shear-Klean Grate Co., Chicago, Ill.
Wickes Boiler Co., Saginaw, Mich.

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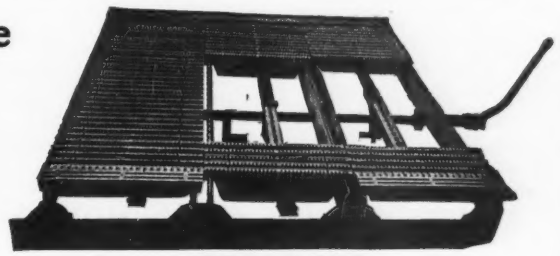

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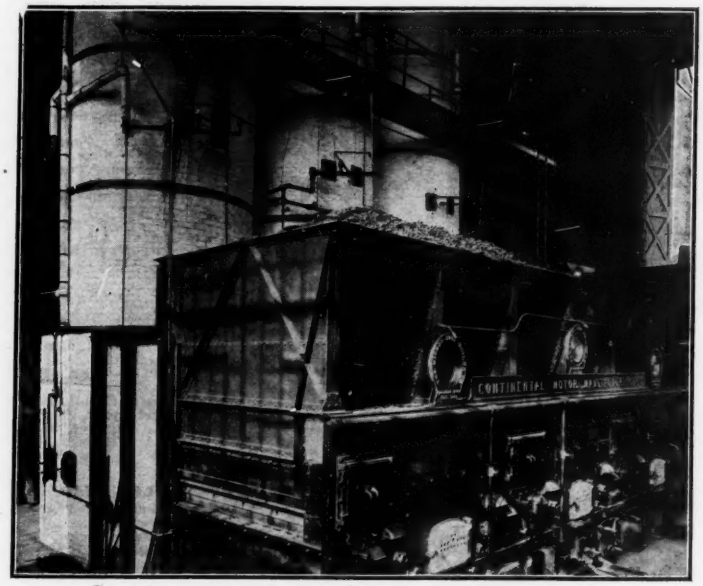

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bring these 5 advantages to your boiler plant

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5 *Save Soot-Blowers*—these "Diamonds" are withdrawn *clear* from heat when not in use.

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GREASE.
Albany Lubricating Co., New York. "Albany."
Cook's Sons, Adam, New York. "Albany."
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
Swain Lubricator Co., Chicago.
United States Graphite Co., Saginaw, Mich.

GREASE CUPS.
(See oil and grease cups.)

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HOISTS.
Ingersoll-Rand Co., New York.
Sprague Electric Works, New York.

HOISTS, ELECTRIC.
Sprague Electric Works, New York.

HOSE, ARMORED.
Sprague Electric Works, New York.

HOSE.
Carpenter & Co., Geo. B., Chicago. "Peerless Perfected."
Diamond Rubber Co., The, Akron, Ohio.
N. Y. Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., New York. "Perfected."
Quaker City Rubber Co., Philadelphia, Pa.

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Wolf Co., Fred W., Chicago, Ill.

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Robertson & Sons, James L., New York. "Robertson-Thompson."
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

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Starrett Co., L. S., Athol, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

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Jenkins Bros., New York. "Sellers."
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Detroit.
Powell Co., The Wm., Cincinnati.
Sherwood Mfg. Co., Buffalo, N. Y.

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Starrett Co., L. S., Athol, Mass.

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Johns-Manville Co., H. W., New York.

INSULATION, CORKBOARD.
Armstrong Cork Co., Pittsburgh, Pa.

INSULATION, COLD STORAGE.
Armstrong Cork Co., Pittsburgh, Pa.

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Lunkenheimer Co., The, Cincinnati, Ohio.
National Tube Co., Pittsburgh, Pa.
Powell Co., The Wm., Cincinnati.

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Johns-Manville Co., H. W., New York.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

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Dixon Crucible Co., Jos., Jersey City, N. J.
United States Graphite Co., Saginaw, Mich.

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Fort Wayne Electric Works, Fort Wayne, Ind. "Wood Systems."
Westinghouse Electric Mfg. Co., Pittsburgh, Pa.

LINK BELT.
Morse Chain Co., Ithaca, N. Y.

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Cook's Sons, Adam, New York, "Albany Grease."
Dearborn Drug & Chemical Works, Chicago, Ill.
Dixon Crucible Co., Jersey City.
International Boiler Compound Co., Chicago, Ill.
Keystone Lubricating Co., Philadelphia, Pa.
Robinson & Son Co., Wm. C., Baltimore, Md.
Steel Mill Packing Co., Detroit.
Swain Lubricating Co., Chicago.
United States Graphite Co., The Saginaw, Mich.

LUBRICATING GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.
United States Graphite Co., Saginaw, Mich.

LUBRICATING OIL CABINETS.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.

LUBRICATORS.
American Injector Co., Detroit.
American Well Works, The, Aurora, Ill.
Cook's Sons, Adam, New York.
Detroit Lubricating Co., Detroit.
Keystone Lubricating Co., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
McCord Mfg. Co., Detroit, Mich.
Powell Co., The Wm., Cincinnati, Ohio. "Trojan."
Richardson-Phenix Co., Milwaukee, Wis.
Sherwood Mfg. Co., Buffalo, N. Y.
Stephenson Mfg. Co., Albany.
Sterling Machine Co., The, Norwich, Conn. "Sterling."
Swain Lubricating Co., Chicago.
Williams Valve Co., D. T., Cincinnati, O.

LUBRICATORS, FORCE FEED.
Lunkenheimer Co., The, Cincinnati, Ohio.
Richardson-Phenix Co., Milwaukee, Wis.
Sterling Machine Co., The, Norwich, Conn. "Sterling."

MECHANICAL DRAFT APPARATUS.
American Blower Co., Detroit, Mich.
Green Fuel Economizer Co., The, Matteawan, N. Y.

OIL.
Albany Lubricating Co., New York. "Albany."
Cook's Sons, Adam, New York. "Albany."
Robinson & Son Co., Wm. C., Baltimore, Md.

OIL AND GREASE CUPS.
Albany Lubricating Co., New York. "Albany."
American Injector Co., Detroit.
Cook's Sons, Adam, New York. "Albany."
Detroit Lubricator Co., Detroit.
Keystone Lubricating Co., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Detroit.
Powell Co., The Wm., Cincinnati.
Sherwood Mfg. Co., Buffalo, N. Y.
Swain Lubricator Co., Chicago.
Williams Valve Co., D. T., Cincinnati, O.

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Bowser & Co., Inc., S. F., Fort Wayne, Ind.
Burt Mfg. Co., Akron, O.
Elliott Company, Pittsburgh, Pa.
Manzel Bros. Co., Buffalo, N. Y.
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Richardson-Phenix Co., Milwaukee, Wis.
Wright Mfg. Co., Detroit, Mich.

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Bowser & Co., Inc., S. F., Fort Wayne, Ind.
Elliott Company, Pittsburgh, Pa.
Lunkenheimer Co., The, Cincinnati, Ohio.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa. "White-Star."
Richardson-Phenix Co., Milwaukee, Wis.

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Goetze Gasket & Packing Co., New Brunswick, N. J.
Steel Mill Packing Co., Detroit. "Safety."
Swain Lubricator Co., Chicago, Ill.

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Carpenter & Co., Geo. B., Chicago. "Rainbow," "Peerless," "Eclipse."
Diamond Rubber Co., The, Akron, Ohio.
Durabla Mfg. Co., New York, N. Y.
Eureka Packing Co., New York.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Mabbs Hydraulic Packing Co., Chicago, Ill.
N. Y. Belting & Packing Co., Ltd., New York. "Karbonite."
Peerless Rubber Mfg. Co., New York. "Rainbow," "Eclipse."
Schiller, Joseph F., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia. "Ebonite," "P. P. P."

PACKINGS, SHEET.
Carpenter & Co., Geo. B., Chicago. "Rainbow," "Peerless," "Eclipse."
Chesterton & Co., A. W., Boston, Mass.
Diamond Rubber Co., The, Akron, Ohio.
Durabla Mfg. Co., New York., N. Y.
Goetze Gasket & Packing Co., New Brunswick, N. J. "Goetzerit."
Graton & Knight Mfg. Co., Worcester, Mass.
Johns-Pratt Co., Hartford, Conn. "Vulcabeston."
Jenkins Bros., New York. Jenkins "96."
Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., Ltd., New York. "Karbonite."
Peerless Rubber Mfg. Co., New York. "Rainbow," "Eclipse."
Quaker City Rubber Co., Philadelphia. "Ebonite," "P. P. P."
Robertson & Sons, Jas. L., New York. "Eureka."

PACKING, VALVE STEM.
Goetze Gasket & Packing Co., New Brunswick, N. J.

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Dixon Crucible Co., Jos., Jersey City, N. J.
United States Graphite Co., Saginaw, Mich.

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Best Mfg. Co., Pittsburgh, Pa.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

PIPE COILS, IRON AND BRASS.
National Pipe Bending Co., New Haven, Conn.

PIPE COVERINGS.
Armstrong Cork Co., Pittsburgh, Pa.
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PIPE CUTTERS.
Armstrong Mfg. Co., Bridgeport.
Curtis & Curtis Co., Bridgeport, Conn. "Forbes."
Toledo Pipe Threading Mach. Co., The, Toledo, Ohio.
Williams & Co., J. H., Brooklyn.

PIPE LINE MEASURES, SELF-REGISTERING.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.

PIPE THREADING MACHINES.
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Borden Co., Warren, O. "Beaver."
Curtis & Curtis Co., Bridgeport,
Toledo Pipe Threading Mach. Co., The, Toledo, Ohio.
Williams & Co., J. H., Brooklyn.

PIPE, WOOD.
American District Steam Co., Lockport, N. Y. "Standard."

PIPE, WROUGHT.
National Tube Co., Pittsburgh, Pa.

PLANIMETERS.
Ashton Valve Co., Boston, Mass.
Robertson & Sons, Jas. L., New York. "Willis."
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."

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United States Graphite Co., Saginaw, Mich.

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Davis Regulator Co., G. M., Chicago.
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d'Este Co., Julian, Boston "Curtis."
Elliott Company, Pittsburgh, Pa.
Foster Engineering Co., Newark.
Hughson Steam Specialty Co., Chicago, Ill. "Eclipse."
Lytton Mfg. Corporation, New York, N. Y.
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Monash-Younker Co., Chicago, Ill.
Ohio Brass Co., The, Mansfield, O.
Robertson & Son, Jas. L., New York.
Schade Valve Mfg. Co., Philadelphia, Pa.
Squires Co., The C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia. "McDaniel."

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American Well Works, The, Aurora, Ill.
Columbian Rope Co., Auburn, N. Y.

PULLEYS, FRICTION CLUTCH.
American Well Works, The, Aurora, Ill.

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McGowan Co., The John H., Cincinnati, Ohio.

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Graton & Knight Mfg. Co., Worcester, Mass.

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Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deane Steam Pump Co., Holyoke, Mass.
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Deming Co., The, Salem, Ohio.
Goulds Mfg. Co., Seneca Falls, N. Y.
Jamieson & Co., M. W., Warren, Pa. "Best."
Jeanesville Iron Works Co., The, Hazelton, Pa.
McGowan Co., The John H., Cincinnati, Ohio.
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Stewart Heater Co., Buffalo, N. Y.
Wheeler Condenser & Engineering Co., Carteret, N. J.
Worthington, Henry R., New York, N. Y.

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American Steam Pump Co., Battle Creek, Mich. "Marsh" and "American."
American Well Works, The, Aurora, Ill.
Cameron Steam Pump Wks., A. S., New York, N. Y.
De Laval Steam Turbine Co., Trenton, N. J.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deane Steam Pump Co., Holyoke, Mass.
Goulds Mfg. Co., Seneca Falls, N. Y.
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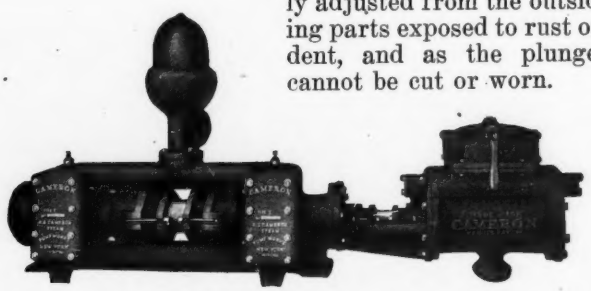

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Wheeler Condenser & Engineering Co., Carteret, N. J.

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Dean Bros. Steam Pump Works, Indianapolis, Ind.
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Cameron Steam Pump Works, A. S., New York, N. Y.

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Manzel Bros., Buffalo, N. Y.
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Penberthy Injector Co., Detroit.
Powell Co., The, Cincinnati, O.
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Williams Valve Co., D. T., Cincinnati, O.

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Cameron Steam Pump Wks., A. S., New York, N. Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
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Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deane Steam Pump Co., Holyoke, Mass.
Goulds Mfg. Co., Seneca Falls, N. Y.

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American Well Works, The, Aurora, Ill.
Cameron Steam Pump Wks., A. S., New York, N. Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Jamieson & Co., M. W., Warren, Pa. "Best."

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Alberger Pump & Condenser Co., New York, N. Y.

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Dean Bros. Steam Pump Works, Indianapolis, Ind.
Goulds Mfg. Co., Seneca Falls, N. Y.
McGowan Co., The John H., Cincinnati, Ohio.
Wheeler Condenser & Engineering Co., Carteret, N. J.
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Hoppes Mfg. Co., Springfield, O.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

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Lagonda Mfg. Co., Springfield, O.
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Watson & McDaniel Co., Philadelphia, Pa.
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Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Schade Valve Mfg. Co., Philadelphia, Pa.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Squires Co., The C. E., Cleveland.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., Pittsburgh.

REPAIRS.
Hartford Engine Works, Hartford, Conn.

RESEATING MACHINES.
Lagonda Mfg. Co., Springfield, O.
Leavitt Machine Co., Orange, Mass.
Quaker City Rubber Co., Philadelphia, Pa.
Schiller, Joseph F., Philadelphia, Pa.

RETURN TRAPS.
Lytton Mfg. Corporation, New York, N. Y.
Nashua Machine Co., Boston, Mass. "Bundy."

ROPE, HEMP.
American Mfg. Co., Brooklyn, N. Y.
Columbian Rope Co., Auburn, N. Y.

ROPE, WIRE.
American Steel & Wire Co., Chicago.

ROPE DRESSING AND PRESERVATIVE.
Cling Surface Co., Buffalo, N. Y.
Stephenson Mfg. Co., Albany, N. Y.

SEPARATORS, AMMONIA.
Direct Separator Co., Syracuse.
Elliott Co., Pittsburgh, Pa. "Liberty-Greenaway."
Williams Valve Co., D. T., Cincinnati, O.

SEPARATORS AND EXTRACTORS, STEAM AND OIL.
Austin Separator Co., Detroit.
Cookson Steam Specialty Co., Cincinnati, Ohio. I. X. L.
d'Este Co., Julian, Boston. "Curtis."
Direct Separator Co., Syracuse.
Elliott Co., Pittsburgh, Pa. "Liberty-Greenaway."
Hoppes Mfg. Co., Springfield, O.
Mosher Water Tube Boiler Co., New York, N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa. "Wyoming."
Pittsburgh Gage & Supply Co., Pittsburgh, Pa. "Pittsburgh."
Strong, Carlisle & Hammond Co., Cleveland, Ohio. "Strong."
Watson & McDaniel Co., Philadelphia, Pa.
Williams Valve Co., The D. T., Cincinnati, Ohio.
Wright Mfg. Co., Detroit, Mich.

SHAFTING RINGS, LEATHER.
Graton & Knight Mfg. Co., Worcester, Mass.

SKYLIGHTS.
Burt Mfg. Co., Akron, Ohio.

STEAM METERS.
St. John, G. C., New York.

STEAM TRAPS.
Albany Steam Trap Co., Albany, N. Y.
American Blower Co., Detroit, Mich. "Detroit."
Amer. Dist. Steam Co., Lockport, N. Y. "Empire."
Anderson Co., The V. D., Cleveland, O. "Improved."
Automatic Steam Trap & Specialty Co., Cleveland, Ohio. "Barton."
Cookson Steam Specialty Co., Cincinnati, Ohio. I. X. L.
Davis Regulator Co., G. M., Chicago.
d'Este Co., Julian, Boston. "Curtis."
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Pittsburgh, Pa.
Hughson Steam Specialty Co., Chicago, Ill. "Eclipse."
Jenkins Bros., New York. "Diamond."
Kitts Mfg. Co., Oswego, N. Y.
Lytton Mfg. Corporation, New York, N. Y.
Morehead Mfg. Co., Detroit, Mich.
Nashua Machine Co., Nashua, N. H. "Bundy."
Nason Mfg. Co., New York. "Sidelug."
National Tube Co., Pittsburgh, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Open Coil Heater & Purifier Co., Indianapolis, Ind.
Reliance Gauge Column Co., Cleveland, O.
Rogers Co., H. A., New York. "Heintz."
Sarco Engineering Co., New York, N. Y. "Sarco."
Squires Co., The C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, O.
Thurtell-Hughson Co., Chicago, Ill. "Chicago."
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., Pittsburgh, Pa.
Williams Valve Co., Cincinnati, O. "Cookson."
Wright Mfg. Co., Detroit, Mich. "Emergency."

STOCKS AND DIES.
Armstrong Mfg. Co., Bridgeport, Conn.
Borden Co., Warren, O. "Beaver."
Curtis & Curtis Co., Bridgeport, Conn. "Forbes."
Toledo Pipe Threading Mach. Co., The, Toledo, Ohio.

STOKERS, MECHANICAL.
Green Engineering Co., Chicago, Ill.
Westinghouse Machine Co., Pittsburgh, Pa. "Roney."

STORAGE BATTERIES.
Westinghouse Machine Co., Pittsburgh, Pa. "Roney."

STRAINERS.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deming Co., The, Salem, Ohio.
Elliott Co., Pittsburgh, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Lagonda Mfg. Co., Springfield, O.

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Babcock & Wilcox, New York.
Heine Safety Boiler Co., St. Louis, Mo.

SWITCHBOARDS.
Fort Wayne Electric Works, Fort Wayne, Ind. "Wood Systems."
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

TACHOMETERS.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."

TAPE, STEEL MEASURING.
Keuffel & Esser, Hoboken, N. J. "K. & E."
Starrett Co., L. S., Athol, Mass.

THERMOMETERS, RECORDING.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

THERMOMETERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N .Y. "S. & B."

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Bristol Co., Waterbury, Conn.
Chesterton & Co., A. W., Boston, Mass.
Mound Tool & Scraper Co., St. Louis, Mo.
Rogers Co., H. A., New York, N Y.
Starrett Co., L. S., Athol, Mass.

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American Mfg. Co., Brooklyn, N. Y.
American Steel & Wire Co., Chicago.
Columbian Rope Co., Auburn, N. Y.

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Lytton Mfg. Corporation, New York, N. Y.
Nashua Machine Co., Boston, Mass. "Bundy."
Open Coil Heater and Purifier Co., Indianapolis, Ind.

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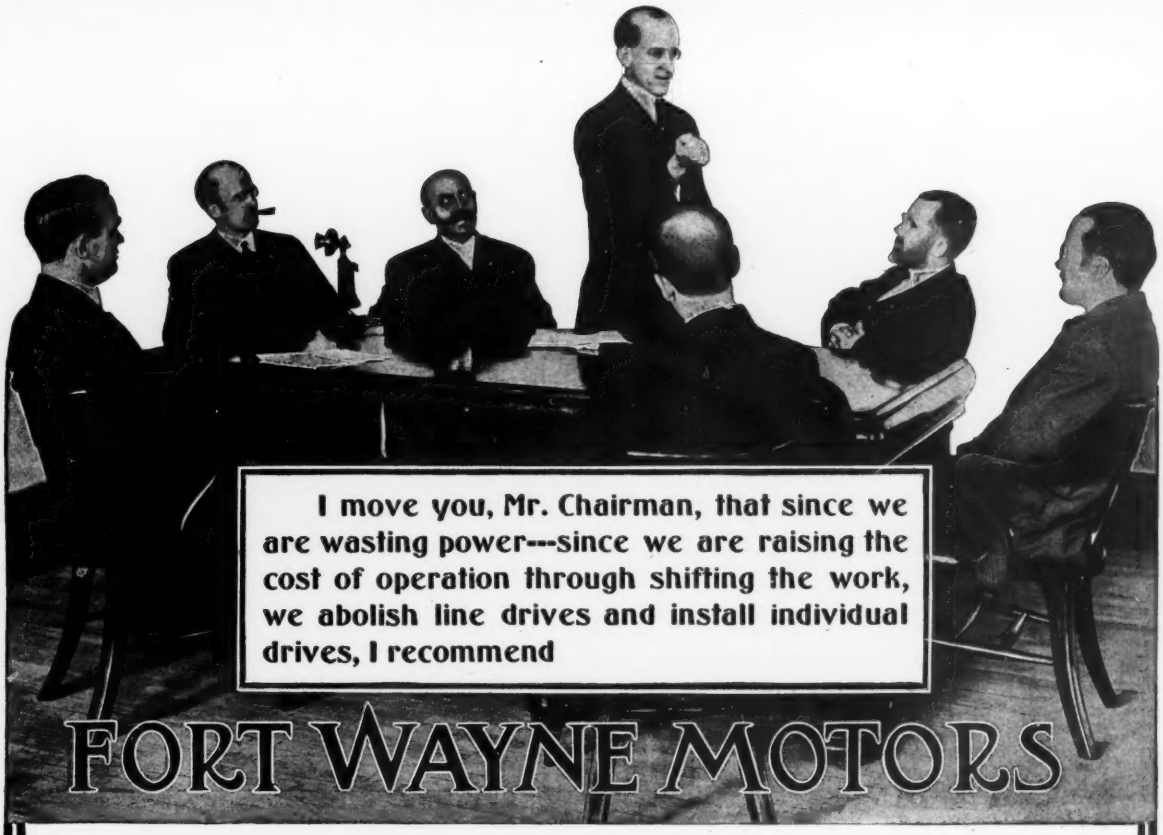
Chesterton & Co., A. W., Boston, Mass.
"Diamond" Power Specialty Co., Detroit, Mich. "Diamond."
Johns-Manville Co., H. W., New York.
Lagonda Mfg. Co., Springfield, O. "Weinland."
Liberty Mfg. Co., Pittsburgh, Pa.
Roto Company, Hartford, Conn.
Sherwood Mfg. Co., Buffalo, N. Y.
Stephenson Mfg. Co., Albany.
Stewart Heater Co., Buffalo, N. Y.

TUBE CUTTERS.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh, Pa.

TUBING.
National Tube Co., Pittsburgh, Pa.

TURBINES, STEAM.
Alberger Pump & Condenser Co., New York, N. Y.
Allis-Chalmers Co., Milwaukee, Wisc.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y. "Curtis."
Hooven, Owens, Rentschler Co., Hamilton, O. "Hamilton-Holzworth."
Kerr Turbine Co., Wellsville, N. Y.
Westinghouse Machine Co., Pittsburgh, Pa. "Westinghouse-Parsons."

UNDERGROUND HEATING SYSTEM.
American District Steam Co., Lockport, N. Y. "Holly."


I move you, Mr. Chairman, that since we are wasting power---since we are raising the cost of operation through shifting the work, we abolish line drives and install individual drives, I recommend
FORT WAYNE MOTORS

Our Engineer's report proves that hardly half of the power we generate ever reaches our machines for useful work. Think of it, gentlemen, nearly 50% of what we pay for power goes to run the line shafting, belts, idlers, etc.

The Production Manager's investigation shows that without buying a single new machine, but by simply rearranging the ones we have so that the material will pass directly from one operation to another, we will not only lower the manufacturing cost of our product, but speed up production so that we can meet the demands of the Sales Department.

Here are the Purchasing Agent's specifications, guarantees and prices on motors from the leading electrical manufacturers and after carefully considering them all it seems that the Fort Wayne line fills our particular requirements better than any other. Their prices are right; their service in the way of engineering advice and deliveries is not surpassed, and their customers have all told us there is no better concern in the country to deal with. Let's 'phone for their salesman.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

If ***YOU*** are not ready just yet to call for our salesman, but wish to learn more concerning the advantages of motor driven machines in your plant, write for our bulletin, "Motor Drives," which illustrates nearly 200 different applications, many of them in your industry.

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OF GENERAL ELECTRIC COMPANY

"Wood" Systems

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Branch Offices–
All Large Cities

M31

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Jefferson Union Co., Lexington, Mass.
Lunkenheimer Co., The, Cincinnati, Ohio.
National Tube Co., Pittsburgh, Pa. "Kewanee."
Powell Co., The Wm., Cincinnati.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American Well Works, The, Aurora, Ill.
Ashton Valve Co., Boston, Mass.
Best Mfg. Co., Pittsburgh, Pa.
Davis Regulator Co., G. M., Chicago.
Deming Co., The, Salem, Ohio.
d'Este Co., Julian, Boston. "Curtis."
Detroit Lubricator Co., Detroit.
Foster Engineering Co., Newark.
Harrison Safety Boiler Works, Philadelphia, Pa.
Homestead Valve Mfg. Co., Homestead, Pa.
Howard Iron Works, Buffalo, N. Y.
Hughson Steam Specialty Co., Chicago, Ill.
Jenkins Bros., New York.
Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Lunkenheimer Co., The, Cincinnati. "Duro."
Mason Regulator Co., Boston, Mass.
National Tube Co., Pitsburgh, Pa.
Ohio Brass Co., The, Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa. "Clean-Seat."
Powell Co., The Wm., Cincinnati, Ohio. "White-Star."
Schade Valve Mfg. Co., Philadelphia, Pa.
Schiller, Joseph F., Philadelphia, Pa.
Squires Co., The C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Valve Co., The D. T., Cincinnati, O.

VALVES, AIR.
Jenkins Bros., New York.
Lunkenheimer Co., The, Cincinnati, Ohio.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Quaker City Rubber Co., Philadelphia, Pa.

VALVES, BALL.
Howard Iron Works, Buffalo, N. Y.
Lunkenheimer Co., The, Cincinnati, Ohio.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

VALVES, BLOW-OFF.
Elliott Co., Pittsburgh, Pa. "Faber."
Jenkins Bros., New York, N. Y.
Lytton Mfg. Corporation, New York, N. Y.
Lunkenheimer Co., The, Cincinnati, Ohio.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa. "Pittsburgh."
Schade Valve Mfg. Co., Philadelphia, Pa.
Schiller, Joseph F., Philadelphia, Pa.

VALVES, BY-PASS.
Lunkenheimer Co., The, Cincinnati, Ohio.
Mason Regulator Co., Boston, Mass.

VALVE DISCS.
Goetze Gasket & Packing Co., New Brunswick, N. J.

VALVES, FLOAT.
Schade Valve Mfg. Co., Philadelphia, Pa.

VALVES, GATE.
Best Mfg. Co., Pittsburgh, Pa.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., The, Cincinnati, Ohio.
Ohio Brass Co., Mansfield, Ohio.

VALVES, GLOBE.
Best Mfg. Co., Pittsburgh, Pa.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., The, Cincinnati, Ohio.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Ohio Brass Co., Mansfield, Ohio.

VALVES, POP SAFETY.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., The, Cincinnati, Ohio.
National Tube Co., Pittsburgh, Pa.
Schade Valve Mfg. Co., Philadelphia, Pa.

VALVES, PUMP CONTROLLING.
Schade Valve Mfg. Co., Philadelphia, Pa.

VALVES, RADIATOR.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., The, Cincinnati, Ohio.
Ohio Brass Co., Mansfield, Ohio.

VALVES, REDUCING.
Elliott Co., Pittsburgh, Pa.
Foster Engineering Co., Newark, N. J.
Lytton Mfg. Corporation, New York, N. Y.
Mason Regulator Co., Boston.
Ohio Brass Co., The, Mansfield, O.
Schade Valve Mfg. Co., Philadelphia, Pa.

VALVES, RELIEF.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Deming Co., Salem, Ohio.
Elliott Company, Pittsburgh, Pa.
Hughson Steam Specialty Co., Chicago, Ill. "Kearn."
Lunkenheimer Co., The, Cincinnati, Ohio.

VALVES, VACUUM PUMP REGULATING.
Mason Regulator Co., Boston, Mass.
Schade Valve Mfg. Co., Philadelphia, Pa.

VALVE RESEATING MACHINES.
Lagonda Mfg. Co., Springfield, Ohio.
Leavitt Machine Co., Orange, Mass.

VALVES, RUBBER.
Jenkins Bros., New York, N. Y.

VALVES, STEEL FOR SUPERHEATED STEAM.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., The, Cincinnati, Ohio.

VENTILATING APPARATUS.
American Blower Co., Detroit, Mich.
Green Fuel Economizer Co., The, Matteawan, N. Y.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa. "Gaco."

VENTILATORS.
Burt Mfg. Co., Akron, O.
Ohio Blower Co., Cleveland, Ohio
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

VISES, PIPE.
Williams & Co., J. H., Brooklyn

WATER COLUMNS AND ALARMS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Elliott Company, Pittsburgh, Pa.
Hughson Steam Specialty Co., Chicago, Ill.
Lunkenheimer Co., The, Cincinnati, Ohio.
Ohio Brass Co., The, Mansfield, O.
Pittsburgh Gage & Supply Co., Pitsburgh, Pa. "Pittsburgh."
Reliance Gauge Column Co., Cleveland, Ohio.
Wright Mfg. Co., Detroit, Mich.

WATER METERS.
Harrison Safety Boiler Works Philadelphia, Pa.

WATER SOFTENING SYSTEMS.
Harrison Safety Boiler Works Philadelphia, Pa.

WHISTLES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., The, Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati.

WRENCHES.
Curtis & Curtis Co., Bridgeport, Conn.
Toledo Pipe Threading Mach. Co., The, Toledo, Ohio.
Kroeschell Bros. Co., Chicago, Ill. "Ideal."
Williams & Co., J. H., Brooklyn, N. Y. "Vulcan," "Big Six."

WRENCHES, FLANGE.
Strong, Carlisle & Hammond Co., Cleveland, Ohio. "Strong."

IF ANYTHING IN YOUR PLANT IS CAUSING YOU TROUBLE—

Why not see whether there is a remedy for it suggested in the advertising pages of this number of Practical Engineer?

These pages put before you the net product of the ingenuity of men whose whole efforts are concentrated on the solution of just such questions as arise in your work.

Don't you think it wise to know how others are steadily diminishing costs and increasing efficiency in their power plants?

There is no readier means of learning this than to keep constantly in touch with the semi-monthly announcements of manufacturers appearing in

The Advertising Section of

PRACTICAL ENGINEER

The Dart Union Has Two Bronze Seats

and these seats are well ground together.

The Dart Union has heavy malleable iron pipe ends, with a heavy shoulder on the swivel end, and a heavy iron malleable nut, which also has a heavy shoulder to support the swivel.

That Bronze to Bronze combination, in the vital part, the seats, settles the question of corrosion.

In the iron parts—the pipe ends—you get all the *strength* you'll ever need—the strength of an iron fitting that doesn't *stretch*.

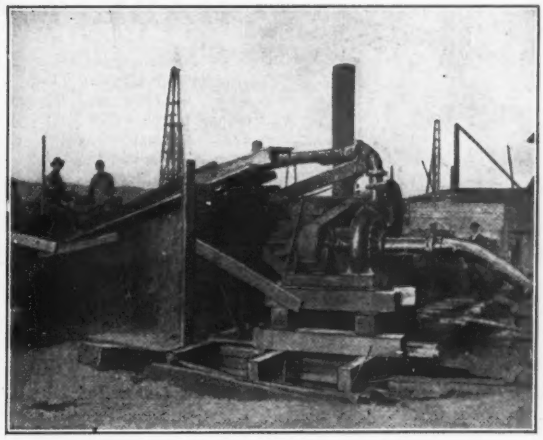
You get a further assurance of satisfactory service through the *Straight Way* right through the Dart Union, without cored parts to weaken, hold water or collect sediment.

And the Dart Union's Standard Pipe Threads mean something to the piper and the man who pays him.

By all means buy the *best* union you can find, but be sure you know which *is* best, by giving them actual service tests. We are ready to supply samples of Dart Unions for that purpose.

E. M. Dart Man'fg. Company
Canadian Factory:
Providence, Rhode Island
Dart Union Co., Ltd., Toronto

The Fairbanks Company, Sales Agents



YOU may need more than this advertisement to convince you that you need Schieren's Duxbak Waterproof Leather Belting where you have always used belts of some "Naturally" waterproof material. But you do.

Leather has been proven to be the best material for power transmission, and before the birth of "Duxbak" a few years ago, its only fault was that it could only be used indoors.

Schieren's Duxbak Waterproof Leather Belting is able to withstand all weather and last longer than ordinary leather would on an inside job, for the process that makes Duxbak Waterproof increases its length of service.

DUXBAK BELTING
TRADE MARK

Chas. A. Schieren Company — Tanners Belt Manufacturers
ESTABLISHED 1848
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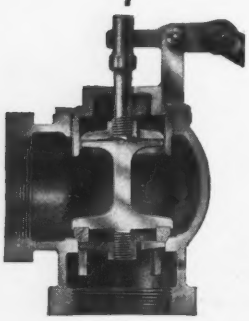
OAK LEATHER TANNERIES, Bristol, Tenn.

Chicago, 123 W. Kinzie St.
Boston, 641-643 Atlantic Ave., Opposite South Station
Philadelphia, 226 North 3rd St.
Denver, 1752 Arapahoe St. Pittsburgh, 205 Wood St.
Brooklyn, N. Y., Cor. 13th St. and Third Ave.
Hamburg, Germany, Auf dem Sande 1



SCHADE BALANCED FLOAT VALVE

An ingeniously constructed and reliable device for automatically controlling the supply of water in open tanks or reservoirs through change in the water level. Positive seating action. No water hammer or chattering. The special water-resisting piston leather and the disc are the only wearing parts, and these are renewed at small cost without removing the valve from the pipe line.

The float which controls the action of the valve is weighted to hold the valve open until the water reaches the float and closes the valve. The float can be adjusted at any angle. The standard pattern Schade Balanced Float Valve is suited for use on cold water pressures up to 200 pounds. Special valves to order for hot water or oil.

Write for Catalog

NOTE The Schade Balanced Control Valves should be used where there is any pressure on the outlet side of the valve.

30 days free trial

SCHADE VALVE MFG. CO., 2546 North American St., Philadelphia, Pa.

The Forbes
Pipe Cutting and Threading Machine
For Hand or Power, Bench or Trench

Will cut and thread pipe bends of all kinds and sizes. Requires only one man.

It is a twentieth century appliance designed and built especially for enterprising Plumbers and Fitters who have no time to experiment. It's built for Speed, Adaptability and Exactness.

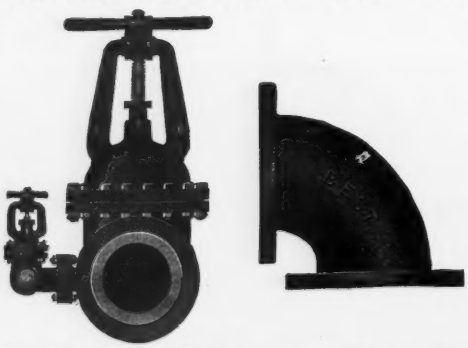
Removable from its base for use as a hand machine on any outside job.

Let us send you our new Catalogue.

The Curtis & Curtis Co., 53 Garden St., Bridgeport, Conn.

"BEST" PIPING "BEST"

WE PIPE POWER HOUSES COMPLETE



Valves — Fittings — Bends

For All Pressures—Any Service

Iron Castings Up To 50 Tons

Our Catalog for the Asking

Best Manufacturing Company

PITTSBURGH, " " PENNSYLVANIA

For Close Regulation Use

Lytton
Stay-Put Reducing Valves

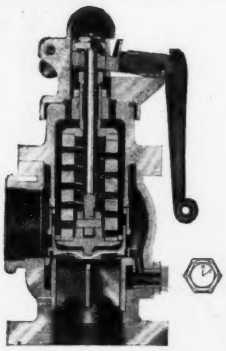
Shut off when consumption stops.

Reduced Pressure can be changed while in operation.

Send for Bulletin No. 4

Lytton Manufacturing Corp.

Sales Office:
50 Church Street, - - NEW YORK
Main Office and Work: Franklin, Va.



Latest No. 20 Style

Long Spring of Jessop's Sheffield Steel. Working Parts of High Grade Steam Metal

The Ashton Improved Lock-Up Pop Safety Valve

Complies With the Latest Revised Laws of the States of Massachusetts and Ohio

(See Sectional Cut Above at Left)

It is made with compound lifting attachment, capable of raising the valve part off the seat, one-eighth the diameter of the valve opening. It has bevel seat at an angle of forty-five (45) degrees, and the spring is encased, protecting it from the volume of steam and preventing back pressure. Also spherical or ball-bearing pressure screw and bottom spring disc. Full size connections to both inlet and outlet. And it has, as exclusive features well known to users of Ashton Valves:

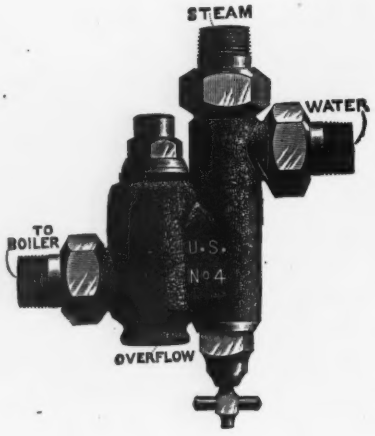
A Knife-edge pop-lip which wears evenly with the seat, insuring an unvarying pop even after long service.

An outside screw plug pop regulator, affording quick and ready means of adjustment of pop while pressure is on boiler and without taking valve apart. Write today for your Free Copy of the Ashton Pocket-size Book of Steam Specialties and Engineering Information.

273 Franklin Street, Boston, Mass.

Branch Offices: 128 Liberty Street, New York; 174 N. Market Street, Chicago

To You and You and All of You, "Merry Christmas"



The Purchase Price of a

"UNITED STATES" AUTOMATIC INJECTOR

is a **small item** but the Saving and Satisfaction and Service which the "U. S." brings are **big.**

It surely **is** a big satisfaction to know that your injector is one that will need no tinkering—that it is always on the job, doing its work better than any other injector could do it,—automatically, dependably, economically. If **you** are **not** experiencing such satisfaction, send right now for catalog "H," pick out the injector you need, and **get** it. If you don't get **satisfaction** along with it, ship it back and get your money.

We'll send you the Engineer's Red Book too, when we mail you catalog "H."

You'll find it a worth-while book,—one you're glad to own.

The American Injector Company

Detroit **180 Fourteenth Avenue** **Michigan**

536

"Columbia" The Gem of Recorders

Thousands in daily operation

The "Columbia" Recording Gauge

with NIGHT and DAY Charts

For steam, air, gas, water, and hydraulic pressures—vacuum draft and mine fan pressures

A big feature of the "Columbia" Recording Gauge is the popular "Night and Day" border chart. One glance at the chart and you have your bearings.

But this is just **one** of the many features which is earning for the "Columbia" a world wide reputation.

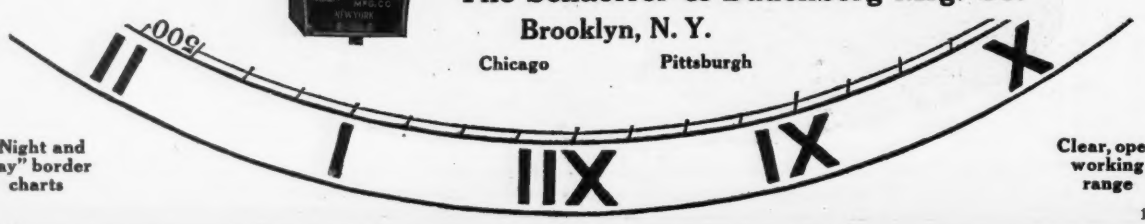
The chief feature of the "Columbia" is its great reliability, then comes its wonderful durability. And coupled with these features is perfect design, workmanship and material throughout. Every single "Columbia" is guaranteed and shipped on approval.

Write now for pamphlet C-105.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, N. Y.

Chicago **Pittsburgh**



"Night and Day" border charts

Clear, open working range

100

TRADE
PENBERTHY
MARK
AUTOMATIC
INJECTOR
PENBERTHY
PENBERTHY
Greeting
May every gift that Santa brings you give as perfect satisfaction as a Penberthy.

New Detroit Catalog

The big, new 232-page Detroit catalog is complete in every way.

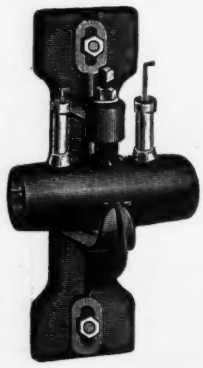
It shows a full line of lubricators for every condition met with on every kind of steam engine, steam pump, air compressor, ammonia cylinder. It fully illustrates and describes Detroit locomotive lubricators and specialties, mechanical force feed oilers for gas engines, hand pumps, glass oilers, brass oilers, grease cups, ground key work, water guages, fusible plugs and others boiler trimmings, valves and a multitude of other devices.

It shows repair parts for all Detroit Lubricators; gives complete instructions for their installation, care and operation and contains valuable information on the general subject of lubrication.

This book will help you with your work

If you would like to know more about lubricators and lubrication, this book should contain the information you want. If it doesn't, our Engineering Service Department will be glad to help you. **Write for Catalog G-9.**

DETROIT LUBRICATOR CO.
DETROIT, U. S. A.
Largest Manufacturers of Lubricating Devices in the World



HONEST!

you don't know what satisfaction it is to have perfect lubrication unless you use Swain's Lubricators—clean, little attention, always in place and economical.

Write for useful Booklet on Perfect Lubrication.

SWAIN LUBRICATOR COMPANY
328 West Lake Street CHICAGO

HOISTS

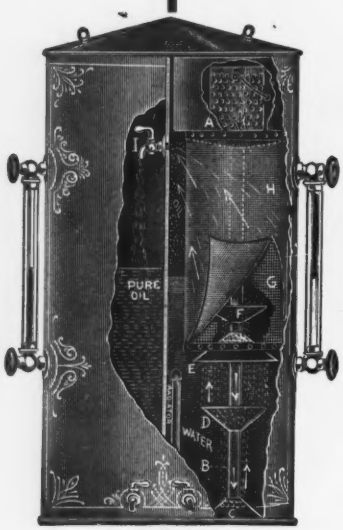
Has your shop reached the limit of its present capacity? Do you know that the installation of a Sprague Hoist has greatly increased the capacity and efficiency of many shop equipments?

Let us tell you about it.

Ask for Pamphlet No. 90169

SPRAGUE ELECTRIC WORKS
OF GENERAL ELECTRIC CO.
Main Office, 527-31 W. 34th St., NEW YORK, N Y.
BRANCH OFFICES IN PRINCIPAL CITIES

The Slower The Better



The slower the movement of the oil in filtering, the more thoroughly is it freed from impurities. The construction of the

Sims Oil Filter

secures an **upward** filtration with the result that a large area of filtering surface is obtained. This compels a slow movement of the oil.

Try One For 30 Days

We have a filter for the smallest or largest requirements—2 to 600 gallons of oil a day. Write us about your needs and for particulars regarding our 30-days' free trial test. Or consult your supply house.

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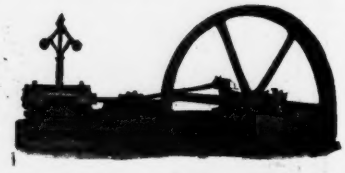

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Eliminate those costly annoyances due to faulty belt joints.

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Descriptive matter on request.

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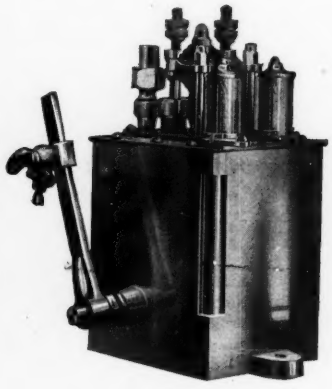

Class B

Lubricators

Write us today and we'll send you a "McCord" for a 30 Day Free Trial.

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A Contented Mind.

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Over in Idaho there's a boat line—The Red Collar—which runs a boat called the "Flyer" on a trip of 120 miles including 12 to 16 stops.

The same engineer has been making the same run for years and has been using a quart of oil for every 2½ trips.

Recently a "McCord" Lubricator was installed on the "Flyer." The same boat has been making five regular trips on one quart of oil ever since. It now does twice the work on the same amount of oil: in other words her oil expenditures have been reduced just one-half.

The superiority of Force Feed over the old style Hydrostatic or Gravity methods or lubrication is well illustrated here.

"McCord" Force Feed Lubricators will do the same for you. They increase efficiency, reduce oil bills and are good boiler insurance from the minute they are installed.

A "McCord" is easily installed and operated and the saving in oil soon pays for it. Write today for Lubricator Booklet "A" which illustrates and describes the mechanism and how it operates.

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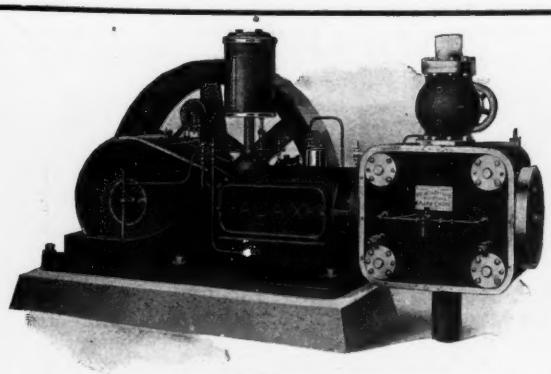
Think "McCord" when you think Lubricator 124



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50% Saving in Oil Bill Guaranteed

If you equip the engines, auxiliaries, ice machines, etc. in your plant with Richardson-Phenix Automatic Oiling and Filtering Systems we guarantee to reduce the oil consumption at least 50% over that required by hand lubrication.

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A post card brings the book. A complete letter brings our "money saving" proposition.

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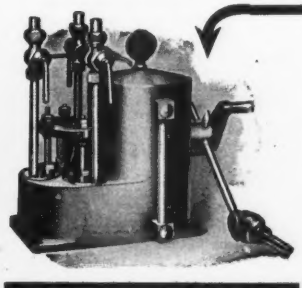

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FORCE FEED LUBRICATORS

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THE "MASTER" MEASURING EXTENSION RULE

A Great Time Saver

Fig. 1

Rigid at All Lengths

This illustration shows a 5-foot MASTER EXTENSION RULE with lower slide extended 2½ inches, making distance between the two extreme points of the rule 10½ inches, as indicated by the arrow.

Fig. 2
This illustration shows how to take an inside measurement of a Window Frame. MASTER EXTENSION RULE shows exact dimensions—where indicated by pencil without figuring or calculations. No guess work.

Fig. 3
This illustration shows how to hold and extend The MASTER EXTENSION RULE.

The MASTER EXTENSION RULE (as shown in Fig. 1) is a newly invented tool and so far superior to any other rule, in real merits, and specifically for taking inside measurements of boilers, doors, windows and furnaces, etc. (as shown in Fig. 2), that it will become indispensable to the engineer after once using it. It is the only practical rule in the WORLD for taking inside measurements.

The MASTER EXTENSION RULE is made of select boxwood and trimmed with brass-plated steel. When extended (as shown in Fig. 4), it is kept in place rigidly by strong steel springs that cannot get out of order.

The MASTER EXTENSION RULE can be opened and closed instantly; the one side (with the name on the top slide) is marked for inside measurements. The reverse side of THE MASTER EXTENSION RULE is just like any other rule, but is particularly valuable for quick measurements of pipes, lumber, ceilings, walls, etc., being so easily extended and closed.

The MASTER EXTENSION RULE measures eight inches when closed. By extending lower slide you have the exact measurement from point to point, as indicated by the arrow in Fig. 1.

HOW TO USE THE MASTER EXTENSION RULE FOR INSIDE MEASUREMENT

Hold rule with left hand (side up with name on top slide) catch lower slide with thumb and index finger of right hand as indicated in Fig. 3. Extend one slide at a time towards the right, permitting each joint to lock (hear the click) until the two extreme points of the rule touch the objects measured between. It will then show exact inside measurements as indicated in Fig. 2. Reverse side used like any other rule.

Fig. 4
This illustration shows a 5-foot MASTER EXTENSION RULE three-quarters extended.

PLEASE NOTE!
That if a zigzag rule breaks you buy a new one, that's all! If The MASTER EXTENSION RULE breaks just mail it to us with return postage and 10 cts. for broken slide and it is repaired and returned promptly.

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Honest, fellows, the instant you touch the stick to the belt you'll notice the result. No waiting. And you can always grab up a stick dressing at the first indication of slipping—apply it at full speed, too, something you can't do in a year of Sundays with liquid dressing.

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A WHOLE HALF POUND STICK OF STEPHENSON BAR BELT DRESSING

A WORD FROM YOU AND THE HALF-POUND STICK IS YOURS

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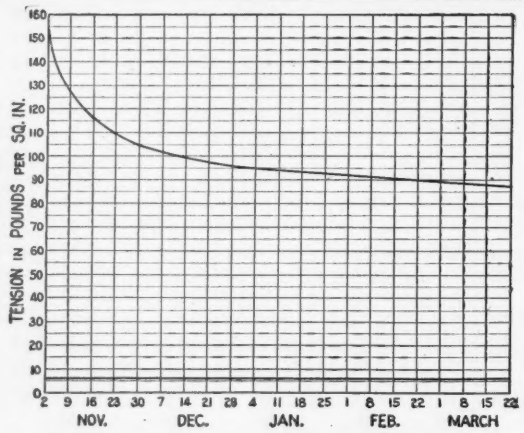


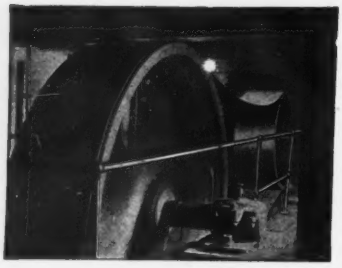
Tight belts and why ultimate economy demands slack belts treated with Cling-Surface

The upper curve (Trans. A. S. M. E. Vol. 31, Page 43) indicates the fall in tension in a leather belt 5⅜ in. wide by 15/32 in. thick, while driving a large rotary planer, and depending upon initial tension to prevent slip. That tightening to prevent slip is dead wrong is well proven by the conditions represented here. Frequent readjustment of the tension here would be necessary, would involve considerable labor expense and would certainly lead to rapid destruction of the belt.

There would be no variation in initial tension if this belt were treated with Cling-Surface for the simple reason that there need be no initial tension other than the weight of the belt. Assuming a distance of 20 ft. between pulley centers and a 5-inch sag (which is small on such a belt filled with Cling-Surface) and figuring for the same belt as used above, there would be but **6 lb. initial tension per sq. in. of belt section,** as plotted plainly on this diagram.

On the average belt treated with Cling-Surface, the idle half, if it's on top, can be run so slack that it will almost touch the working half, and this slackness increases contact areas on both driving and driven pulleys. A 40 per cent increase of contact area is not uncommon and this with the interior flexibility and surface softness imparted by the Cling-Surface gives the belt a maximum gripping power and transmission efficiency.

A Cling-Surface-treated belt does the useful work at best economy because the bearings need not be loaded with useless tension, and this invariably means a saving of lubricants, decreased attention, less danger of broken pulleys, hot boxes, strained shafting and broken belts, and a power economy that for the entire system reaches an astonishing figure. Besides this, Cling-Surface keeps the belt mellow, soft and strong, waterproofed and preserved.



A trial order and a fair test will prove to your entire satisfaction that Cling-Surface is a real money saver on any leather — canvas, camel's hair, rubber or balata belting, regardless of the duty. Ask for literature.

Cling-Surface Co.

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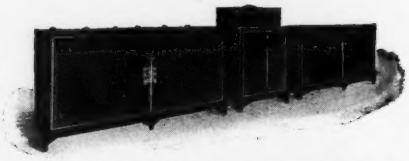
42

At Gary Indiana

In the largest private power plant in the world, where engines developing approximately 200,000 horsepower are used,

You'll Find the "White Star" Continuous Oiling System



This installation of "White Star" Filters (Multiplex Type, as illustrated above) handles a daily supply of nearly 500,000 gallons of oil, and saves thousands of dollars annually for the Steel Corporation.

The same saving can be made in your plant in exact proportion to the amount of oil used.

No matter whether your plant is large or small, the installation of a "White Star" Oiling System will reduce your oil account.
It will mean a saving of 50 to 85 per cent.
We guarantee at least a 50 per cent saving.
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makes tight joints, but never sets. Steam, gas and waterproof. Saves time, prevents damaged tools and fittings. Sample 96-D free.

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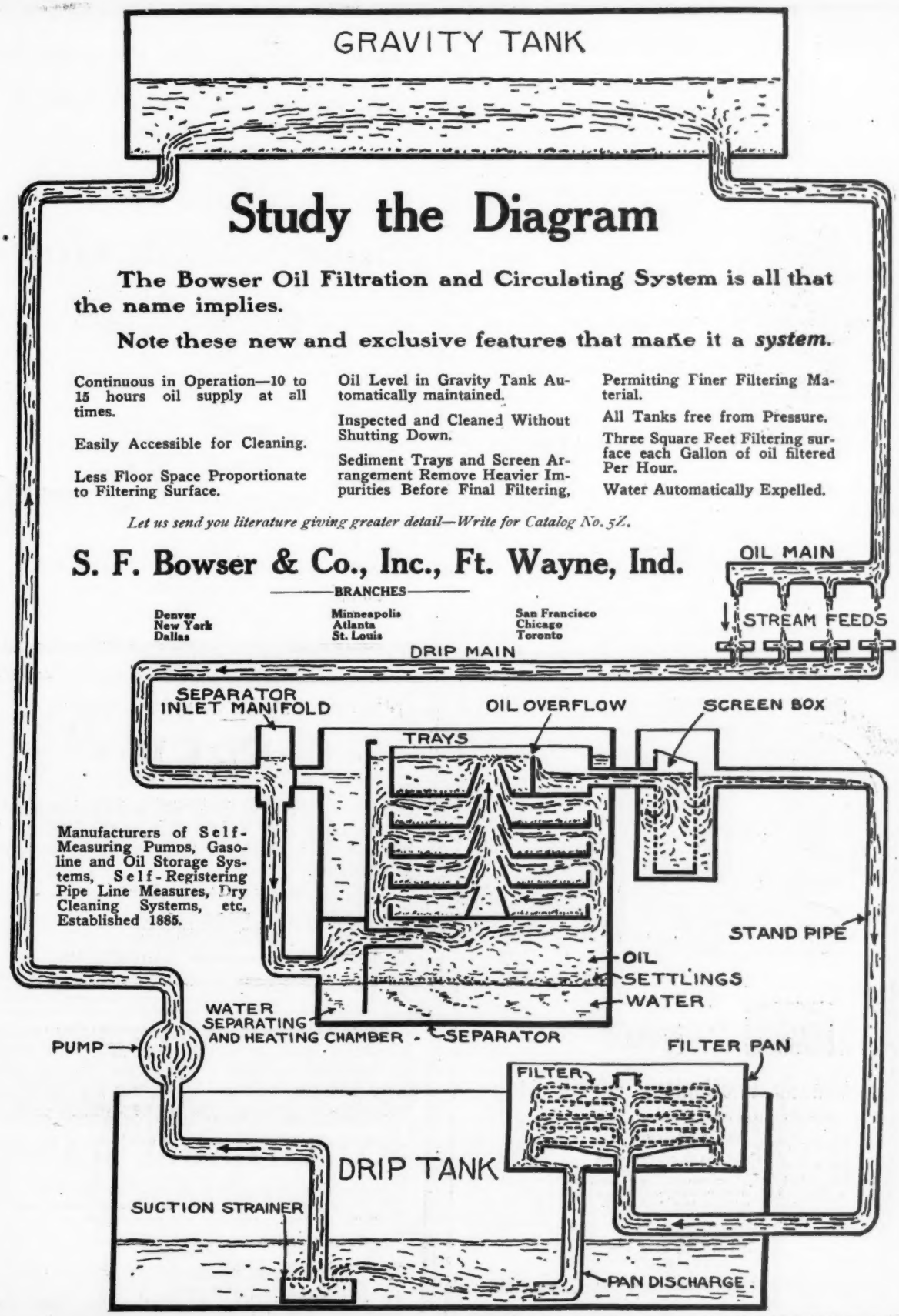

Study the Diagram

The Bowser Oil Filtration and Circulating System is all that the name implies.

Note these new and exclusive features that make it a *system*.

Continuous in Operation—10 to 15 hours oil supply at all times.

Easily Accessible for Cleaning.

Less Floor Space Proportionate to Filtering Surface.

Oil Level in Gravity Tank Automatically maintained.

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Three Square Feet Filtering surface each Gallon of oil filtered Per Hour.

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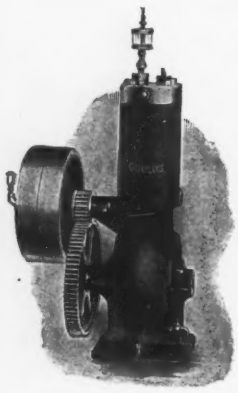
Goulds Air Compressors For Operating Pneumatic Tools, Sprinkler Systems, Etc.



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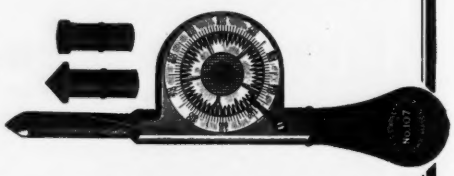

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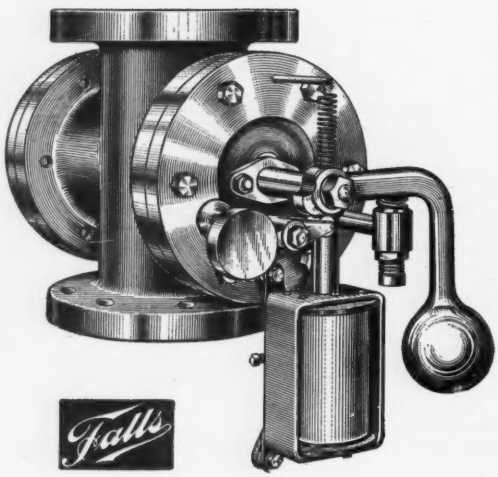

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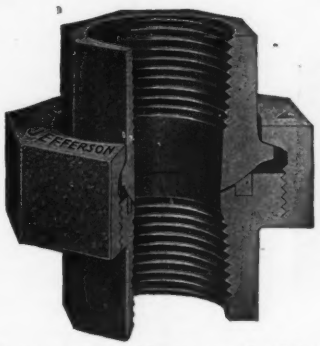

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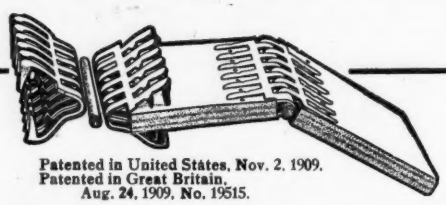

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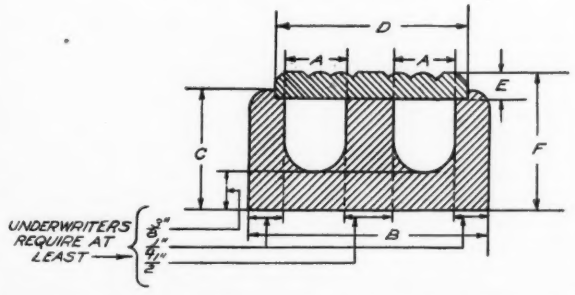
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7

CARRYING CAPACITY OF STANDARD WROUGHT IRON AND STEEL STEAM PIPES, FOR SATURATED STEAM

Nominal Pipe Size, Inches	Velocity in Feet Per Min. =V	Gage Pressure Pounds Per Square Inch									Area of Pipe Sq. in. =A
		80	90	100	125	150	175	200	225	250	
		Pounds of Steam Delivered Per Minute. =P.									
1	4000	5	6	6	7	9	10	11	12	14	0.86
	6000	8	9	10	12	13	15	17	19	21	
	8000	10	11	12	15	17	19	22	25	27	
	10000	13	14	15	18	22	25	28	31	34	
1¼	4000	9	10	11	13	15	17	20	22	24	1.50
	6000	14	15	16	20	23	26	29	33	36	
	8000	18	20	21	26	30	35	39	44	48	
	10000	23	25	27	32	38	44	49	54	60	
1½	4000	12	13	15	18	20	23	26	30	33	2.04
	6000	18	20	21	26	31	35	40	44	48	
	8000	25	26	29	35	41	47	53	59	65	
	10000	31	33	37	44	52	59	66	74	82	
2	4000	20	22	24	29	34	39	44	49	54	3.36
	6000	30	33	36	44	50	58	66	73	80	
	8000	40	44	48	58	68	77	88	98	106	
	10000	50	55	61	73	85	98	109	122	135	
2½	4000	29	32	34	41	48	55	62	69	77	4.78
	6000	43	47	51	62	72	83	93	104	114	
	8000	58	62	68	82	97	110	124	139	152	
	10000	72	78	86	103	121	139	155	173	190	
3	4000	44	49	53	63	74	85	96	107	118	7.38
	6000	66	73	79	96	111	128	144	160	176	
	8000	89	96	106	128	149	170	192	214	234	
	10000	111	121	133	160	187	214	240	267	295	
3½	4000	59	65	71	85	99	114	129	144	158	9.89
	6000	89	98	106	129	149	171	193	215	236	
	8000	119	130	142	170	202	228	258	287	314	
	10000	149	162	178	214	251	287	322	358	396	
4	4000	76	84	92	110	127	146	166	185	204	12.73
	6000	114	125	136	166	191	221	248	277	304	
	8000	153	166	182	219	258	291	331	370	404	
	10000	191	209	230	275	323	370	414	462	510	
4½	4000	96	106	115	137	160	184	208	232	256	15.96
	6000	144	158	171	208	240	277	312	347	380	
	8000	192	208	229	275	324	367	415	465	508	
	10000	239	262	288	345	405	465	518	580	637	
5	4000	120	132	144	172	200	230	260	290	320	19.98
	6000	180	197	214	260	300	346	390	435	476	
	8000	240	260	286	345	405	460	520	580	635	
	10000	300	328	360	433	507	580	650	725	800	

STANDARD TWO-WIRE WOODEN MOULDING

All dimensions are given in inches



A Size of Groove	Will Accommodate Wires		B	C	D	E	F
	Solid	Stranded					
⅜	14 to 12		1½	⅜	1½	⅜	1½
⅜	10 to 8	8	1½	⅜	1½	⅜	1½
⅜	9 to 4	5 to 6	2¼	1	1½	⅜	1
⅜	3 to 0	4 to 1	2¼	1 ⅛	1½	⅜	1½
½		0 to 4-0	2¼	1¼	2 ⅛	½	1½
½		4-0 to 250,000	3¼	1¼	2 ⅛	½	1½
1		250,000 to 500,000	3¼	1¼	2 ⅛	½	1½

Kirkpatrick Manufacturing Company. The products of various manufacturers vary somewhat in dimensions.

Specific and Latent Heat of Various Food Products

Substance	Composition		Specific Heat Above Freezing in Heat Units	Specific Heat Below Freezing in Heat Units	Latent Heat of Freezing in Heat Units
	Water	Solids			
Lean beef	72.00	28.00	0.77	0.41	102
Fat beef	51.00	49.00	.60	.34	72
Veal	68.00	32 00	.70	.39	93
Fat Pork	39.00	61.00	.51	.30	55
Eggs	70.00	30.00	.76	.40	100
Potatoes	74.00	26 00	.80	.42	105
Cabbage	91.00	9 00	.98	.48	129
Carrots	83.00	17.00	.87	.45	118
Milk	87.50	12.50	.90	.47	124
Oysters	80.38	19.62	.84	.44	114
Whitefish	78.00	22.00	.82	.43	111
Eels	62.07	37.93	.69	.38	98
Lobster	76 62	23.38	.81	.42	108
Pigeon	72.40	27.60	.78	.41	102
Chicken	73 70	26 30	.80	42	105

The figures in the last column showing the latent heat of freezing, have been obtained by multiplying the latent heat of freezing water, which is 142 heat units, by the per cent. of water contained in the different materials considered, for as the solid constituents remain in their original condition, only the liquid or watery portion of these materials are concerned in the solidification or freezing of them.

SPECIFIC HEAT OF LIQUIDS

Substance	Sp. Ht.
Ammonia liquid	0.886 to 1.228
Ammonia gas constant press	0.508—0.52
Ammonia gas constant vol.	0.3913—0.40
Sulphur Dioxide (Liq.)	0.277—0.33—0.41
Carbon Dioxide (Liq.)	0.60—0.79—1.00

CALCIUM-CHLORIDE BRINE (LORENZ)

Sp. Gr.	Sp. Ht.	Sp. Gr.	Sp. Ht.
1.00	1.00	1.175	.759
1.050	.948	1.200	.732
1.100	.858	1.225	.706
1.125	.825	1.250	.681
1.150	.792		

SODIUM-CHLORIDE BRINE

Sp. Gr.	Sp. Ht.
1.007	0.992
1.037	0.960
1.073	0.892
1.115	0.855
1.155	0.829
1.191	0.783

CARRYING CAPACITY OF STANDARD WROUGHT IRON AND STEEL STEAM PIPES, FOR SATURATED STEAM

Nominal Pipe Size, Inches	Velocity in Feet Per Min. =V	Gage Pressure Pounds Per Square Inch									Area of Pipe Sq. in. =A
		80	90	100	125	150	175	200	225	250	
		Pounds of Steam Delivered Per Minute. =P.									
6	4000	173	191	208	248	289	332	376	420	463	28.88
	6000	260	285	310	376	434	500	564	627	688	
	8000	347	376	414	498	585	665	750	838	916	
	10000	433	473	520	625	733	840	940	1045	1155	
7	4000	233	256	279	333	387	446	503	563	620	38.74
	6000	349	382	415	504	581	670	755	840	923	
	8000	465	504	554	666	784	892	1007	1125	1226	
	10000	580	635	698	838	982	1125	1260	1405	1550	
8	4000	300	330	360	430	500	575	650	725	800	50.02
	6000	450	492	535	650	750	865	975	1085	1190	
	8000	600	650	715	860	1010	1155	1300	1450	1585	
	10000	750	820	900	1080	1265	1450	1625	1810	2000	
9	4000	376	415	452	538	627	722	816	910	1005	62.72
	6000	565	618	672	816	943	1083	1225	1362	1493	
	8000	752	816	895	1078	1267	1445	1630	1820	1990	
	10000	942	1030	1130	1355	1590	1820	2040	2270	2510	
10	4000	473	520	567	677	788	907	1025	1143	1260	78.82
	6000	709	776	843	1024	1182	1363	1537	1710	1875	
	8000	946	1025	1128	1360	1592	1815	2050	2285	2500	
	10000	1180	1290	1420	1700	1995	2283	2560	2850	3150	
11	4000	570	627	683	817	950	1092	1235	1377	1520	95.03
	6000	855	936	1016	1235	1425	1640	1853	2060	2266	
	8000	1140	1235	1358	1635	1920	2185	2470	2758	3010	
	10000	1425	1558	1710	2052	2405	2755	3085	3440	3800	
12	4000	678	745	813	972	1131	1300	1470	1640	1810	113.09
	6000	1017	1113	1210	1470	1695	1958	2204	2450	2690	
	8000	1356	1470	1617	1945	2280	2600	2940	3280	3582	
	10000	1690	1850	2034	2440	2860	3280	3670	4090	4520	

Formula $P = \frac{AV}{144S}$

NOTATION—P=Pound of Steam Delivered per minute.
A=Area of Pipe in Square Inches.
V=Velocity of Steam in Feet per Minute.
S=Specific Volume, or Cubic Feet of Steam per Pound at the Given Pressure.

To Find Weight of Steam Delivered per Hour, Multiply the Values in Table by 60.

3½, 7, 9 and 11 inch Pipe are Odd Sizes, at Times not Easily Obtained on the market.

Computed by WM. F. FISHER.

LOGARITHMS.

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1 2 2	3 4 5	6 6 7
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1 2 2	3 4 5	5 6 7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1 2 2	3 4 5	5 6 7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1 2 2	3 4 5	5 6 7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1 1 2	3 4 4	5 6 7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1 1 2	3 4 4	5 6 7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1 1 2	3 4 4	5 6 6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1 1 2	3 4 4	5 6 6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1 1 2	3 3 4	5 6 6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1 1 2	3 3 4	5 5 6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1 1 2	3 3 4	5 5 6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1 1 2	3 3 4	5 5 6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1 1 2	3 3 4	5 5 6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1 1 2	3 3 4	5 5 6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1 1 2	3 3 4	4 5 6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1 1 2	2 3 4	4 5 6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1 1 2	2 3 4	4 5 6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1 1 2	2 3 4	4 5 5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1 1 2	2 3 4	4 5 5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1 1 2	2 3 4	4 5 5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1 1 2	2 3 4	4 5 5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1 1 2	2 3 3	4 5 5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1 1 2	2 3 3	4 5 5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1 1 2	2 3 3	4 4 5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1 1 2	2 3 3	4 4 5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1 1 2	2 3 3	4 4 5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1 1 2	2 3 3	4 4 5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1 1 2	2 3 3	4 4 5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1 1 2	2 3 3	4 4 5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1 1 2	2 3 3	4 4 5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1 1 2	2 3 3	4 4 5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1 1 2	2 3 3	4 4 5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1 1 2	2 3 3	4 4 5
87	9396	9400	9405	9410	9415	9420	9425	9430	9435	9440	0 1 1	2 2 3	3 4 4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0 1 1	2 2 3	3 4 4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0 1 1	2 2 3	3 4 4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0 1 1	2 2 3	3 4 4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0 1 1	2 2 3	3 4 4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0 1 1	2 2 3	3 4 4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0 1 1	2 2 3	3 4 4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0 1 1	2 2 3	3 4 4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0 1 1	2 2 3	3 4 4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0 1 1	2 2 3	3 4 4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0 1 1	2 2 3	3 4 4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0 1 1	2 2 3	3 4 4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0 1 1	2 2 3	3 3 4

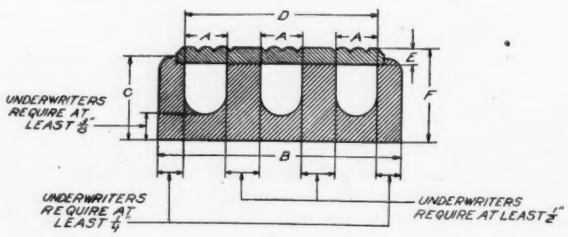
Cold Storage Temperatures

Articles	Degr. Fahr.
Fruit	
Apples	32-36
Bananas	34
Berries, fresh	36
Cranberries	35-36
Cantaloupes	40
Dates, figs, etc.	50-55
Fruits, dried	35-40
Grapes	34-36
Lemons	35-36
Oranges	34-36
Peaches	34-36
Pears, watermelons	34-36
Meats	
Brined	38
Beef, fresh	33
Beef, dried	36-40
Calves	32-33
Hams, ribs, shoulders (not brined)	30
Hogs	29-32
Lard	38
Livers	29-30
Sheep, lambs	32
Ox-tails	30
Sausage casings	30
Tenderloin, butts, etc	33

Articles	Degr. Fahr.
Fish	
Fresh fish	29
Dried fish	36
Oysters in shell	30-35
Oysters in tubs	25
Canned Goods	
Sardines	35-40
Fruits	35-40
Meats	35-40
Butter, Eggs, etc	
Butter	18-20
Butterine	18-20
Cheese	34
Eggs	31
Liquids	
Beer, ale, porter, etc.	33
Cider	30
Ginger ale	36
Wines	40-45
Flour and Meal	
Buckwheat flour	36-40
Corn meal	36-40
Oat meal	36-40
Wheat flour	36-40

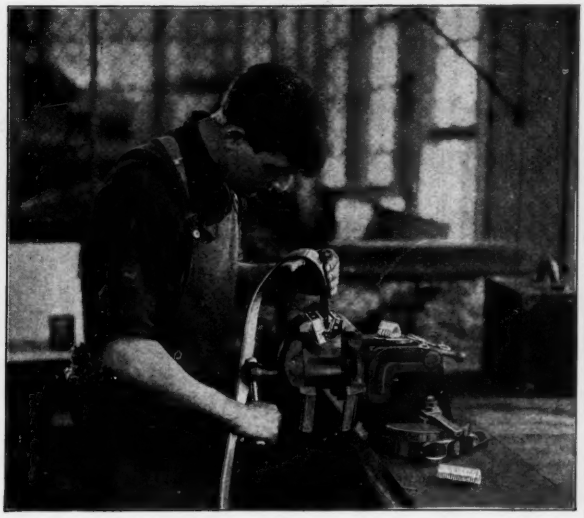
Articles	Degr. Fahr.
Vegetables	
Asparagus	34-35
Cabbage	34-35
Carrots	34-35
Celery	34-35
Dried beans	32-40
Dried corn	35
Dried peas	35-40
Onions	36
Parsnips	34-35
Potatoes	36-40
Sauerkraut	35
Miscellaneous	
Cigars, tobacco	35
Furs, woolens, etc.	35
Honey	45
Hops	40
Maple syrup, sugar	40-45
Oils	35
Poultry, dressed, iced	28-30
Poultry, dry picked	26-28
Poultry, scalded	20
Game, to freeze	15-18
Game, after frozen	25-28
Poultry, to freeze	15-18
Poultry, after frozen	25-28
Nuts in shells	33-40
Chestnuts	33

STANDARD THREE-WIRE WOODEN MOULDING



A Size of Groove	Will Accomodate Wires		B	C	D	E	F
	Solid	Stranded					
1/4	16 to 12		2 1/4	1 1/16	1 1/4	1/4	1 1/16
5/16	10 to 8	8	2 1/4	1 1/16	2 1/4	1/4	1 1/16
3/8	8 to 4	5 to 6	3 1/4	1	2 1/16	1/4	1 1/4
7/16	3 to 0	4 to 1	3 1/2	1 1/16	3	1/4	1 1/4
1/2		0 to 4-0	4 1/4	1 1/4	3 1/2	1/4	1 1/16
9/16		4-0 to 250,000	4 1/2	1 1/2	3 1/4	1/4	1 1/2
1		250,000 to 500,000	5 1/4	1 1/2	4 1/2	1/4	1 1/2

A Great Combination Our "BABY" With a Vise



See How Easy It Is to Make A Perfect Joint!

With the aid of a vise, our "Baby" Lacer will do a neat, quick job on any kind of belt up to and including 4 inches. It is especially recommended for plants with few belts, which do not include a great variety of sizes. It is inexpensive and guaranteed to do perfect work.

The "Clipper"
TRADE MARK

for Better, Quicker Belt Lacing

The "Clipper" is a marvel of simplicity and ease in operation. No experience needed—anyone can make a perfect joint with it at the first attempt. The loss of time caused by broken belts, is greatly reduced by the use of a "Clipper." Let us send you one for free trial. If it does not prove our claims, you can return it without obligation. If it does—you won't be willing to do without it. Ask your supply house about it or

Write us for Illustrated Catalog, describing our "Baby" Lacer and our No. 2.

Clipper Belt Lacer Company

Successors to J. B. Stone Co.

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FOR 600 VOLTS OR LESS.

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Guaranteed to be a strictly high grade Insulated Wire.
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THERE are *good* Wires and *bad* Wires but the Wire with this tag is the *best!*

We *guarantee it!*

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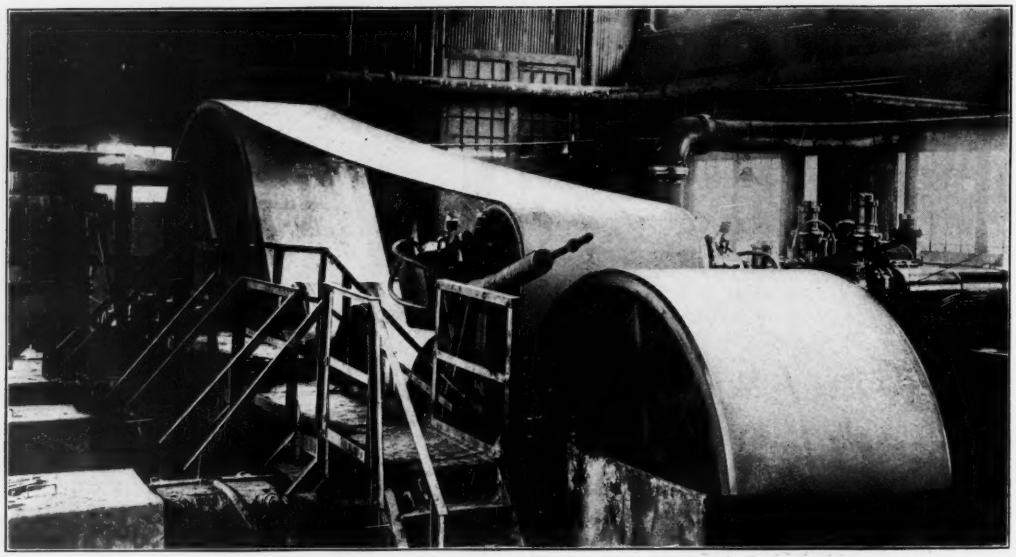

WHERE NO OTHER BELT DID THE WORK

This 60-in. SPARTAN BELT

took the load, developing maximum power from start to finish. This mammoth steel mill, one of the largest in the world, could not find a belt capable of properly driving its rolling mill. The great chunks of iron rolled, blocked the mill—this and exposure to oil caused the belts to slip excessively, resulting in a fast depreciation of their transmission qualities. The 60″ 3-Ply SPARTAN BELT was then installed. Read what the master mechanic says NOW.

"Since we put a 60″ SPARTAN BELT on this mill we have had no trouble whatever. It runs along like a top, never showing any signs of slipping—never injured by oil. We are exceptionally well pleased with it and if there are any other places where we need a wide belt again, SPARTAN will get the preference."

A story like that—one of the costs cut—of efficiency promoted—of power saving—is of vital interest to every belt user. SPARTAN BELTING is made in all sizes, every belt guaranteed to resist heat friction, steam, water, oil, and gas and acid fumes; furthermore, we guarantee that when used under the same conditions SPARTAN belting will last longer and give better service than any other belting material.

FREE BOOKLET

Send for a SPARTAN Booklet. Its 24 pages contain invaluable information to every belting consumer. Just fill in and mail us the coupon. You will get booklet by return mail.

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That Will Not Corrode Must Be Made of Materials That Resist Such Action.

Alberger Heaters

Not Only Resist Corrosion, But Have The Construction That Properly Takes Care of The Expansion no Matter How Great. Write For Details.

Tell Us Your Heater Problems, The "ALBERGER" Will Solve Them And Give You Complete Satisfaction. Vertical or Horizontal in all Sizes.

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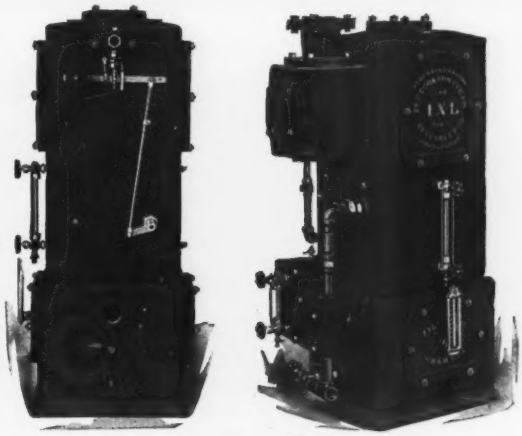

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FEED WATER HEATER AND RECEIVER
PURIFIERS
HIGH AND LOW PRESSURE STEAM TRAPS
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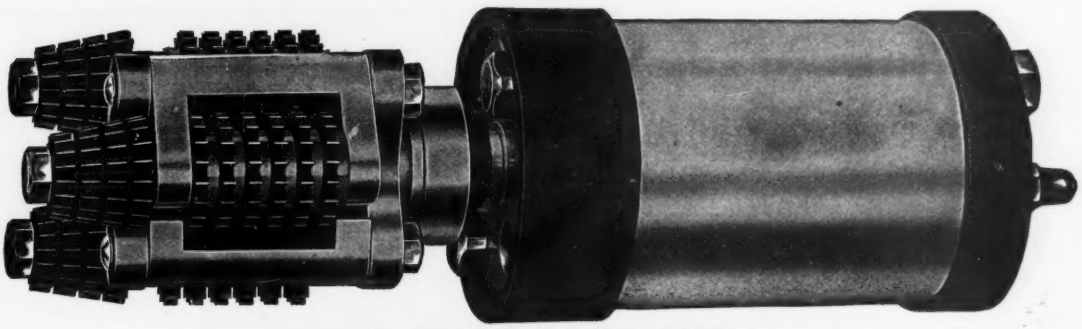


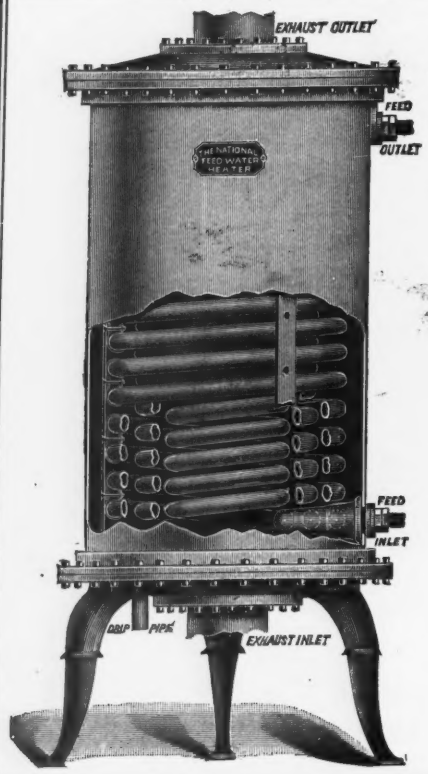
Send for Catalog No. 37 | Rapid, Safe | **ROTO TUBE CLEANERS** The New Roto Positive-Balanced Motor | Economical Durable | THE ROTO CO. Hartford, Conn.

It Certainly Is Some Shock

when you find you've picked up the wrong machine and can't let go. If there's a single sore-headed, disappointed owner of a Patterson-Berryman Feed-Water Heater and Purifier, we don't know who or where he is, for every Patterson-Berryman is sold under a Guarantee that gets the buyer his money back and saddles the return freight on us if the Heater is not perfectly satisfactory in every particular during an Actual Service Test 60 Days Long. In our Book on the Patterson-Berryman is a list of 1770 users and that, mind you, is only a *partial* list. Get it and ask the users in *your* neighborhood what *they* think of the Patterson-Berryman.

Frank L. Patterson & Co., 24 Cortlandt St., New York

Also Manufacturers of Hot Water Heaters of all styles, for all purposes, for use with exhaust or live steam, or in connection with low pressure heating systems.



How Can Any Engineer Permit The Escape of Exhaust Steam

Surely he can figure the available heat in it.
Then why not use it?
The engineer who suggests a

National Feed Water Heater

stands in with the management because it's so easy to show economy.

The *National* is the one to buy for its coils never show the leaks of straight tubes. The feed water never comes in contact with the shell—nor with the exhaust steam containing oil. Feed water, clean and hot (210 to 212 degrees)—saves coal and adds to the life of the boiler.

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National Pipe Bending Company
157 Lloyd Street
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46-11

A Willing Worker--Three Jobs at Once And All Well Done

The "Otis" heats the feed water to the boiling point with the exhaust steam. Separates the oil from the exhaust. Removes all impurities from the water. Performs all three functions so as to ensure a clean, safe and economical boiler plant.

No other feed water heater is sold with so many guarantees—12 in number—as the "Otis." The guarantees cover every detail of construction and operation. Our catalog explains just why we are able to do this. Write for it.

Write For Catalog

The Otis Tubular Feed Water Heater, Oil Separator and Purifier

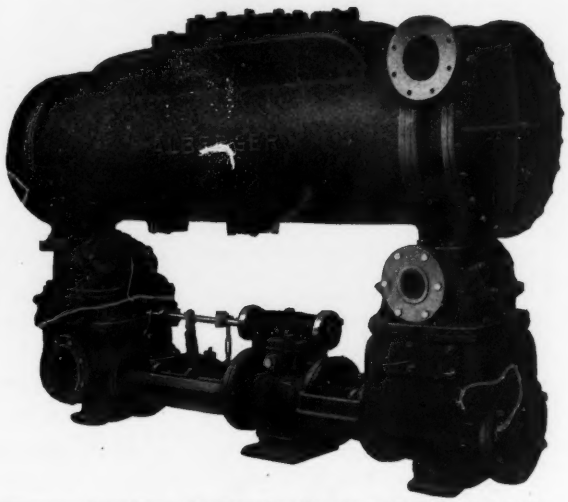
Write For Catalog

The large capacity of the "Otis" allows the water to pass very slowly through it. It separates all mud, sediment and scum from the water; and carries off the condensation from the exhaust steam.

The "Otis" can be more easily and thoroughly cleaned than any other heater. The sediment is deposited in the cool settling chamber at the bottom, from which it is quickly removed, as it cannot bake on in scale. Note the settling chamber.

THE STEWART HEATER COMPANY
7 Norfolk Avenue, Buffalo, N. Y.

Alberger Condensing Apparatus



Alberger Standard Surface Condenser with Combined Air and Circulating Pumps

Jet Barometric Surface

Complete equipments of any size or type; planned, designed and built; strictly high grade and embodying all the latest and best features of condenser practice.

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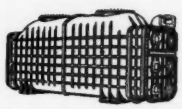
Surface, Barometric and Jet Condensers, Feed Water Heaters, Centrifugal Pumps, Rotative Dry Vacuum Pumps, Wheeler-Edwards Air Pumps, Wheeler-Barnard Cooling Towers, Wheeler-Balcke Cooling Towers (natural draft), Castings for Chemical Industries, etc.



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The Pioneer American Condenser Builders

Branches in all large cities

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Are of the strong, heavy type of construction demanded by the work they have to do and proven best for the purpose by

Half a Century of Experience

We make dredging pumps of every variety for ever purpose—special designs for different materials and running conditions.

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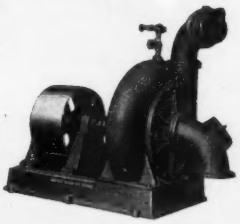

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HENION & HUBBELL, Agts., 221-223 N. Jefferson St., Chicago
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Steam BEST Pumps

The service they give is best appreciated where working conditions are hardest—their dependability is most in evidence where dependability is of first importance.

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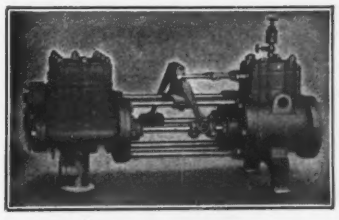

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Steam and Power PUMPS

MARSH AND AMERICAN

Reputation Built on Quality
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Pumps for Every Service.

115,000 in Successful Operation

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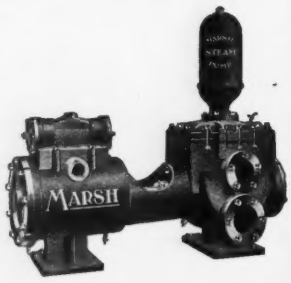
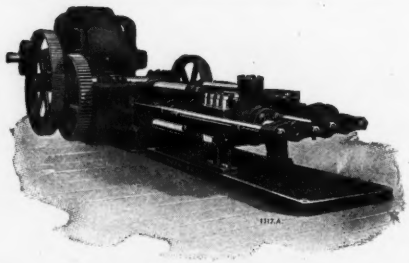


AMERICAN STEAM PUMP CO.
Battle Creek, Michigan



Hydraulic Pumps For Extraordinary Pressures

This electrically driven model is particularly recommended for duty wherever exceedingly high pressure is required. The pump cylinders and valve blocks are constructed of hammered steel with an especial view to making them absolutely unbreakable under the severest kind of duty.

Dean Bros. Duplex Forged Steel Type

is suitable for working pressures up to 8000 pounds per square inch. Write for illustrated Catalog.

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NOT IN THE PUMP TRUST.

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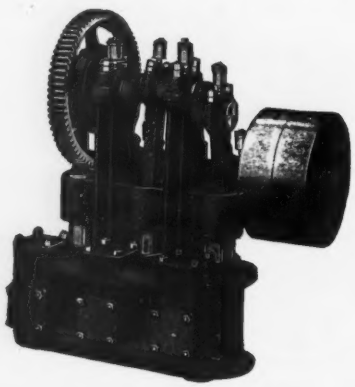
Deming Power Pumps

Best For Power Plants



If you have a steam boiler feed pump and would measure the amount of steam it comsumes, you would write us for particulars of our power driven pumps which can be operated by any power and pay for themselves in a short time.

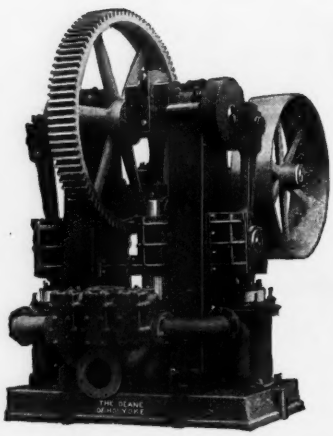
The Deming Company

Salem, Ohio.

Henion & Hubbell, 221-223 North Jefferson Street, Chicago
Harris Pump & Supply Company, 320-322 Second Ave., Pittsburgh, Pa

Deane Power Pumps

THE HIGRADE PUMP



FOR

ELEVATOR SERVICE

or any kind of service Deane has a pump which will fit the requirements.

DEANE POWER PUMPS

for boiler feeding are sure to please

Bulletin D58-51 Illustrates and describes our Single Acting Outside Packed Plunger Pumps.

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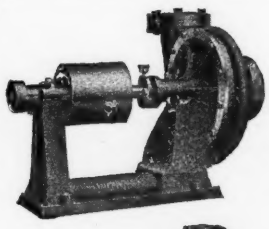
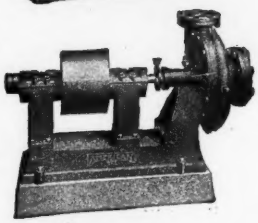
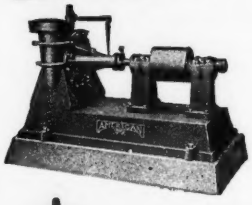
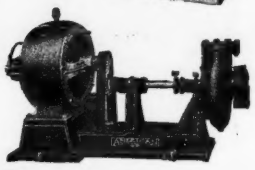
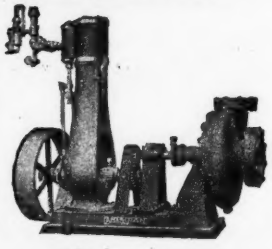
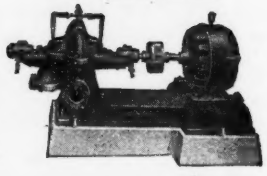
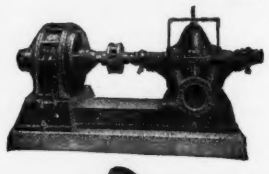

AMERICAN

The Cheapest Pump

When You Consider All the Costs

Pump efficiency means nothing to the inquiring mind unless all costs necessary to *obtain* and *maintain* that efficiency are considered.

It's the man with the ability to include *all* costs in his estimate: first cost, foundation cost, housing cost, attendance cost, repair cost, pumping time lost cost, and the *average* efficiency maintained as compared with the total duty done, and who figures interest on the investment to include *foundations, ground* and *buildings;* who recognizes the greater economy of the

"American" Centrifugal Pump

Two to five times the first cost, two to five times the foundation cost, two to five times the ground cost, two to five times the housing cost, two to five times the attendance cost, two to five times the repair cost and an efficiency that in average use is nearly always far below rated efficiency, due to wear in the valves, are points advocates of old style plunger pumps like to ignore.

American Centrifugals attain up to 82 per cent efficiencies and they not only *attain* them but *maintain* them.

Moreover, they meet practically all pumping conditions larger than a 10-inch deep drill-hole.

The reason is that no matter what the pumping conditions may be we have a special type of centrifugal especially designed to meet the requirements and as an evidence of it we show just a few of our standard types of centrifugals on this page.

And don't imagine that "American" Centrifugals are *low head* pumps. Nearly any of our standard types of centrifugals, in medium or large sizes, will maintain their maximum efficiencies as single stage pumps when operating against 125-feet heads with an equal increase in head for each additional stage.

If this all-the-cost economy interests you sit down right now and write for catalog 117, the most complete centrifugal pump catalog published.

The American Well Works

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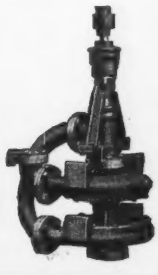
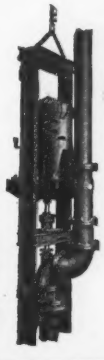
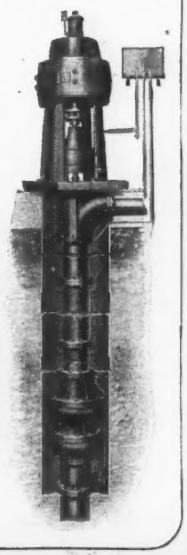

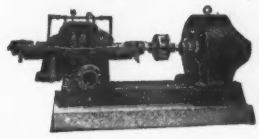
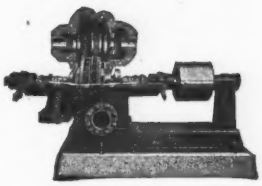
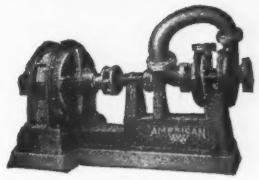
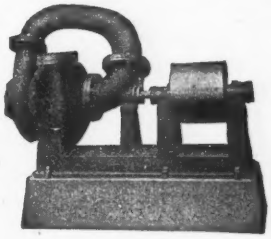

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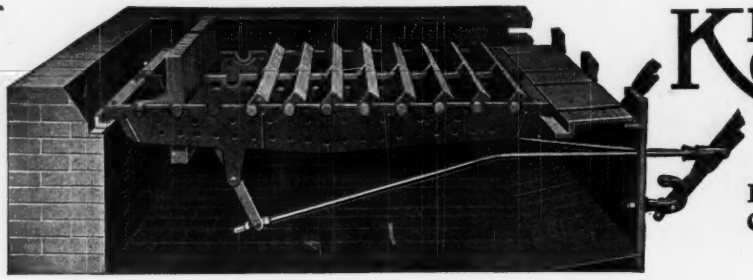

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Rocking and Dumping

Easy to Operate

Built to Suit Your Requirements

It is true flexibility of the Kelly idea in furnace grate construction that enables us to meet every individual demand. The Kelly grate is built with air openings to suit the fuel you burn—slack, screenings or higher grades. Offers least resistance to the passage of air, but also properly supports the fuel. Saves the fireman's time and labor in regulating and cleaning his fires and ensures freedom from dust and dirt in the boiler room. A great economizer of fuel.

Write for Catalog "B," giving descriptive details.

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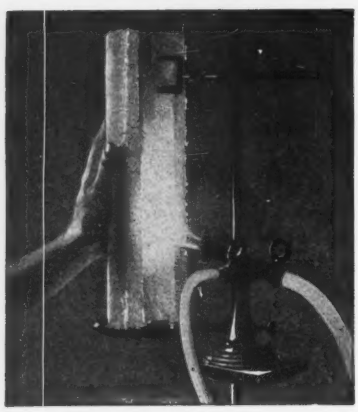
NONPAREIL HIGH PRESSURE COVERING

Another Efficiency Test That You Can Make



Nonpareil Coverings are made from a material new, but by no means untried - that is, diatomaceous earth combined with asbestos fibre. Diatomaceous earth is made up of the skeletons of minute plants, billions to the cubic inch, each filled with air. It is practically pure silica. As air entrapped in minute particles is the most efficient insulating medium known, it can readily be seen why Nonpareil Covering is the ideal high pressure and superheat covering.

Here is another test that you can make that proves both the efficiency of Nonpariel Covering as a non-conductor and its proof against high temperatures. Heat one side of a piece of Nonpareil Covering with a blow pipe until it is white hot. You can still place your hand against the other side without discomfort. Then when it is at white heat, plunge it for a moment into cold water. A few hair-line cracks will develop, but otherwise the surface will remain smooth, uninjured and hard. Try this experiment with any other kind of covering and draw your own conclusions from the results. Nonpareil High Pressure Coverings: (1) Are more efficient non-conductors of heat. (2) Withstand temperatures at which other coverings calcine and disintegrate. (3) Possess much greater moisture-resisting power. (4) Are easy to apply and reasonable in cost. Send for a sample and make the efficiency test yourself.

Nonpareil High Pressure Covering

For Steam Lines and Boilers

Made in sectional, block and cement form. Catalogue S-33 on request.

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Insulation Department

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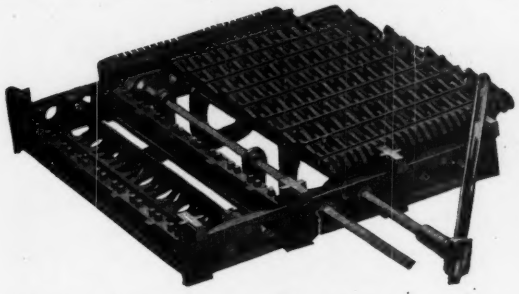
NONPAREIL HIGH PRESSURE COVERING



Not Another Grate in the World Like It

Far Advanced Over Dumping Grates

There is no need to dump with the Shear-Klean. You want the grate under your boilers because it is the ***only one*** which will keep fires clean. It cuts the forming clinkers.

You need it. Write us.

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Monadnock Block, CHICAGO, ILLINOIS
Factory, East Chicago, Ind.
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For Water Tube and Tubular Boilers

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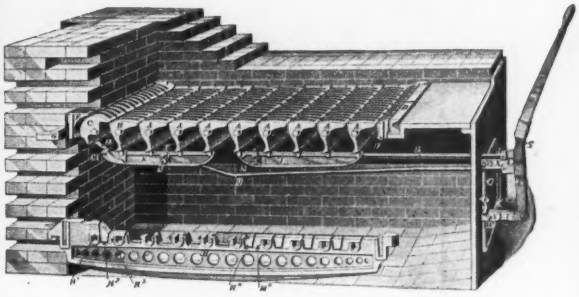
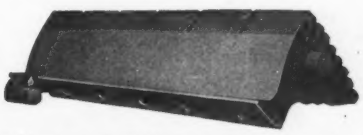
McClave Grates and Argand Blowers

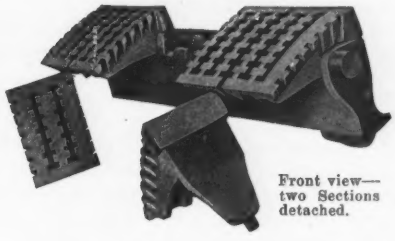


McClave Grate No. 2, is a new type shaking and cut-off grate. The top is made in sections which can be replaced individually, and prevents the body portion of the bars from warping or burning out. The shaking and cut-off movements can be made with fire doors closed. McClave Grate No. 2 is made with meshes of different sizes to suit the fuel used. Ample air space for perfect combustion.

McClave Grate 4-A in combination with McClave's Argand Steam Blower, gives better results than any other where the smaller sizes of anthracite are used. This grate also has a removable sectional top, the top line of the body portion being 2¼ inches below the bottom of the fire.



Back view of McClave Removable Sectional-Top Grate Bar No. 2



Front view—two Sections detached.

Cut Repair Bills

The separate casting of the top portion of the bar insures strength and durability; also reduces repair costs, as only one section has to be replaced in case of breakage. If you are interested in the question of economy through the use of cheap fuels, write for Catalog D.

McClave-Brooks Company
SCRANTON, - PENNA.

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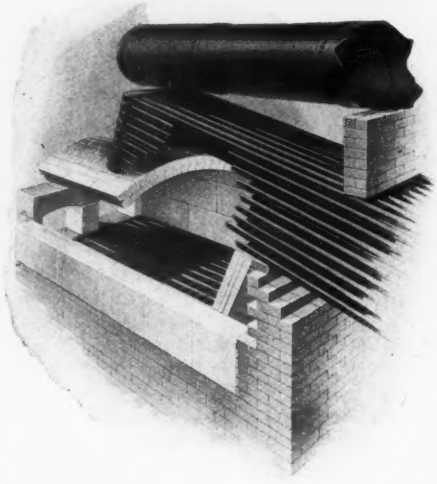
Door Arches, Furnace Roof, Sidewalls



A Modern Firebox

The cut shows how the tongue and groove idea is applied throughout the entire furnace. By means of this construction, large blocks can be used without danger of having open joints between them. The interlocking tongue and groove keeps the joint closed.

The boiler door arch is made up of a few correctly shaped pieces. They fit together and also fit the front. This type of arch has great simplicity and durability. The side wall blocks make a smooth and lasting lining for the fire box. Clinkers can be removed from it without the destructive results which occur when scraping them off of ordinary brickwork. The large, tongued and grooved roof arch blocks are able to undergo the severe stresses set up by expansion and contraction without becoming displaced.

The great simplicity of this style of construction can be seen at a glance. That it is, easier to erect than small brick work is one thing which makes it cheaper. In addition to this, it lasts as long again in most cases and very often three or four times as long.

The material is our own specially developed refractory, "Steel Mixture." It has been on the market many years and is regularly used in thousands of plants.

We can ship from stock to fit practically any case. We would like to estimate on your needs. Write for our "Measurement Booklet" so you can send us the necessary information on which to base our quotation.

McLeod & Henry Co., Troy, N. Y.

New York Office, 1402 Broadway
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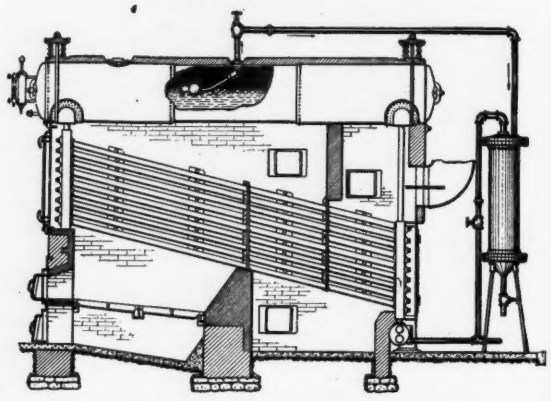
Always On Top



The Buckeye Boiler Skimmer

is always on top of the water—the only device of this kind which floats. Removes the impurities as fast as they are forced on the top. Prevents scale from forming in the tubes or on the plates. Keeps the boiler clean, increases steaming capacity, cuts fuel bills, doubles the life of the boiler. Always busy. Needs no attention. Wherever used, gives perfect satisfaction. Write for catalog and particulars regarding **Free Trial For Thirty Days.**

The Buckeye Boiler Skimmer Co.

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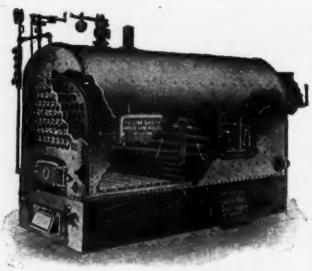

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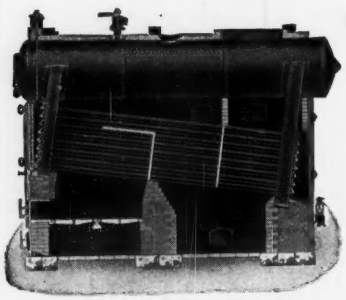

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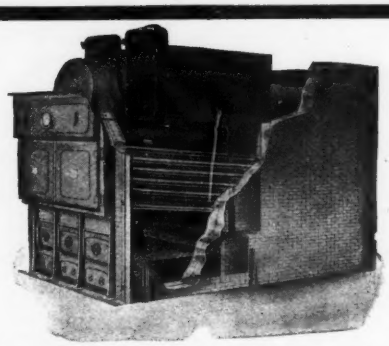
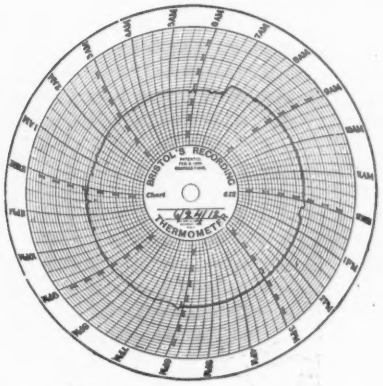
SCOTCH BOILERS

DRY AND WATER-BACK

The Kingsford Water Tube Boiler



"Superheater chart from a Heine boiler, equipped with a Heine Superheater, showing the close regulation of superheat temperature from 7 to 12 and from 12:30 to 6, while the load is on. While the load is off at noon and during the night, and the superheater is acting simply as additional steam storage space and there is no circulation of steam through it to absorb heat, the damper is shut, cutting off the supply of combustion gases to the superheater, so that the temperature of the steam does not rise to a dangerous temperature with liability of burn-out of the tubes, but falls to a temperature near that of the boiler. No flooding is necessary and deposit of scale is eliminated."



CONSTANT SUPERHEAT

IT is of prime importance that superheat be maintained constant. With ordinary superheaters the temperature varies with the load, the rate of driving of the boilers, the furnace temperature and the temperature of the gases of combustion, the cleanliness of the superheater surface and the amount of scale inside of the superheater tubes.

Fluctuations and changes in the degree of superheat are undesirable because any drop in superheat means sacrifice in economy, secondly, because fluctuations in the other direction, that is, undue rise of temperature will cause ruptures of cast iron parts and fittings, warping of valves and lubrication troubles with reciprocating engines.

In the third place, fluctuations and changes in the degree of superheat, even though the temperature may not be unduly high, will cause cracking and failure of cast parts. With the

Heine Superheater

constant superheat is maintained, regardless of the demand for steam and independently of the rate of combustion, the load on the boiler, or the temperature of the combustion gases.

The superheater is located in a small independent setting at the side of the drum and above the water line, connected with the furnace by a small flue through which hot gases pass. The volume of these gases is controlled by a damper in the outlet of the setting which may be regulated by hand or by an automatic temperature regulator. The position of the damper determines absolutely the temperature of the steam which may not only be controlled to any desired mean, but which may be adjusted any time to meet plant conditions more favorably.

When saturated steam is desired the damper is closed. When no steam is demanded, or when a boiler is cut out or banked, it is unnecessary to flood the superheater, since closing of the damper prevents any heating of the tubes whatsoever. **NO FLOODING IS NECESSARY.** The tube surface may be maintained at high efficiency because steam nozzles can be easily introduced through the hollow stay bolts of the superheater header to blow the soot from the tubes.

Heine Superheaters may be installed on all types of boilers now in service, or in connection with new equipment. For further details, write for our Booklet "Superheater Logic" and outline the conditions of service for which you wish Superheaters.

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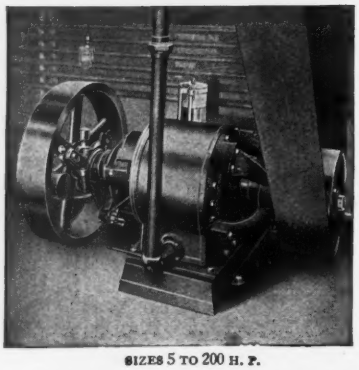
A Guaranteed Engine



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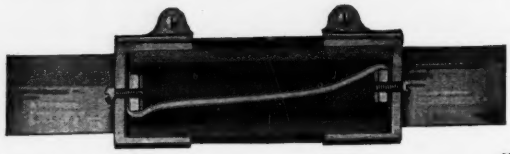

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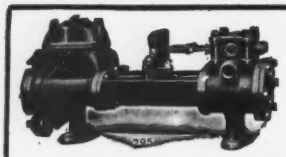

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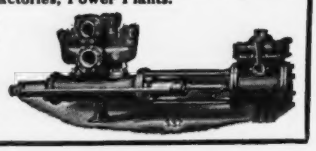

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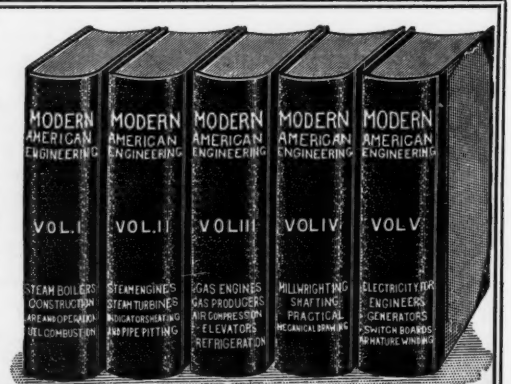
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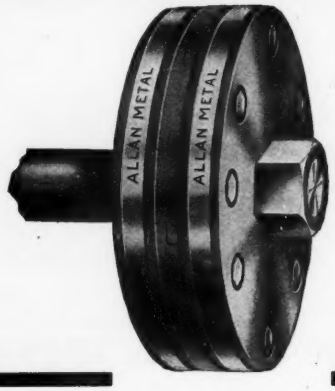

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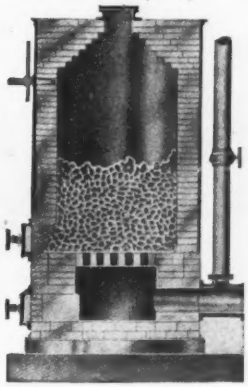

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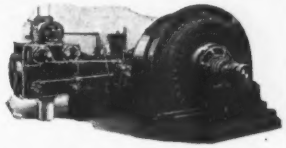

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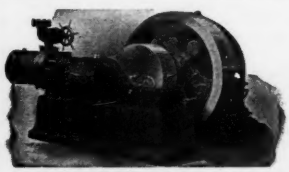

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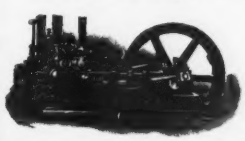

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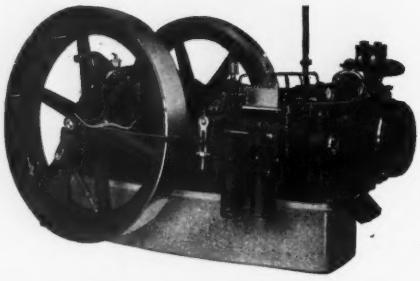

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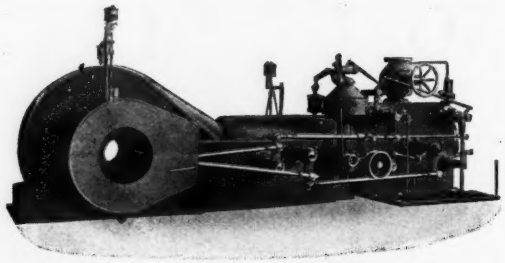

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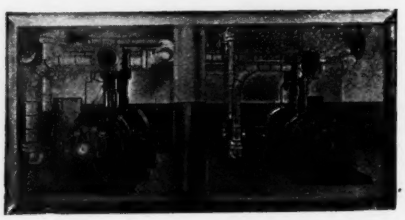

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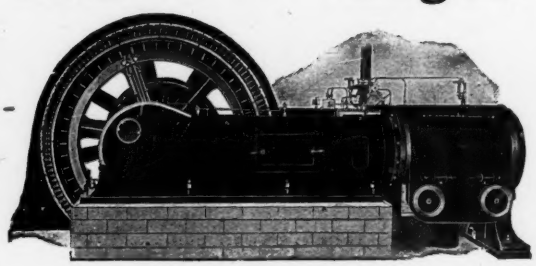

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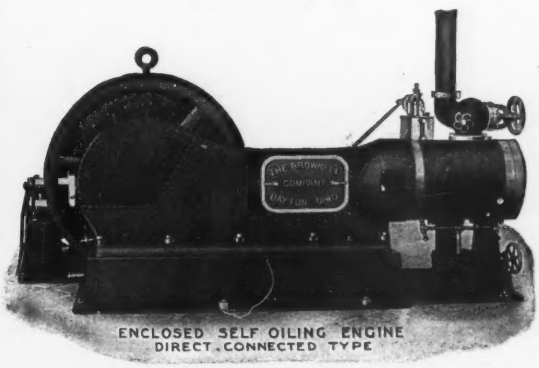

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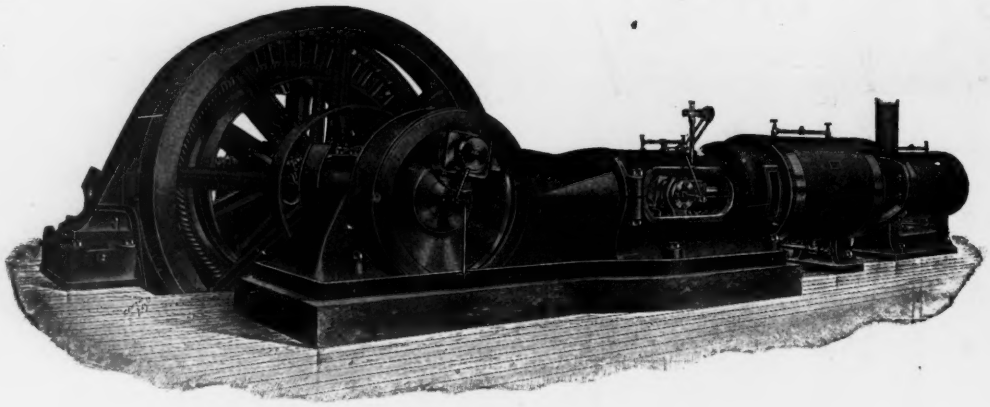

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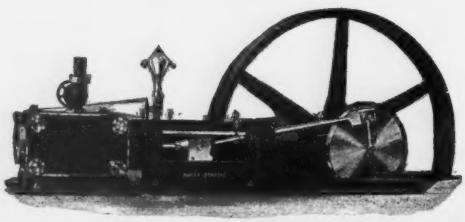

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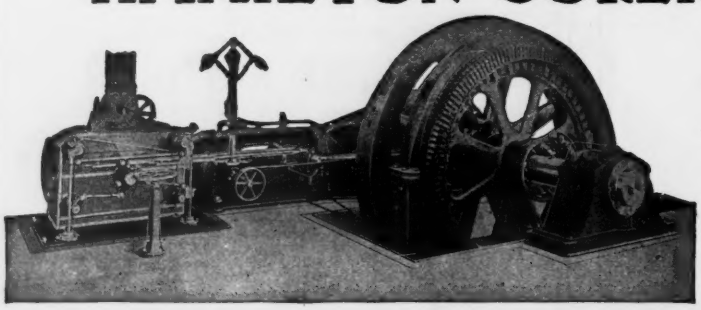

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